

# **A Summary of the October 2003 Battle Creek Workshop**

By

Randall Brown

and

Wim Kimmerer

for the  
Science and Ecosystem Restoration Programs  
of the California Bay-Delta Authority

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## Introduction

In this report we summarize the presentations and discussions from an October 7 and 8, 2003 workshop on Battle Creek – the site of the Coleman National Fish Hatchery (Coleman NFH) and a major salmonid restoration project. The summary is intended as a partial written record of the proceedings.

We prepared the summary based on the presenters' presentation slides and notes we took during the workshop. The presenters have reviewed summaries of their sessions and their comments incorporated. We assume final responsibility for the material selected and the final product.

In 2003 the California Bay-Delta Authority's (CBDA) Science and Ecosystem Restoration programs convened a panel of fish biologists to examine the potential effects of the Coleman NFH on the restoration of Battle Creek. The panel consisted of the following members, all recognized experts in their respective fields.

- Jim Lichatowich (Chair), Fisheries Biologist, Alder Creek Consulting. formerly with the Oregon Dept. of Fish and Wildlife – salmon management, history of salmon management, salmon ecology and life history.
- Craig Busack, Washington Dept. of Fish and Wildlife – salmonid genetics, hatchery risk assessment.
- Dave Hankin, Professor and Chair, Dept. of Fisheries Biology, Humboldt State University – population dynamics, fishery harvest management policy, hatchery practices.
- Reg Reisenbichler, Research Fishery Biologist, Biological Resources Division, U.S. Geological Survey – population biology of salmonids and genetics aspects of hatchery-wild interactions.
- Ron Hedrick, Professor, Dept. of Medicine and Epidemiology, University of California, Davis – infectious diseases of fish and shellfish.

The CBDA convened the biological panel in response to stakeholder concerns that operation of the Coleman NFH could adversely affect the Battle Creek restoration program – a program that could provide significant benefits to all four Central Valley races of Chinook salmon and steelhead rainbow trout. The stakeholders requested that an independent panel be assembled to address the issues they had identified in several reports (for example, Kier Associates 1999).

We worked with the CBDA and stakeholders to develop a set of questions to be given to the panel and to provide the information needed to address those questions. The questions posed to panel were:

1. What level of risk does the operation of the fish barrier dam and ladder at Coleman NFH pose to salmonid populations in a restored Battle Creek?
  - a. Can the barrier dam and ladder be operated in a way that is compatible with full life history expression of steelhead and four races of chinook in a restored Battle Creek?
  - b. What are the risks to carrying capacity of Coleman NFH-origin fall chinook and steelhead adults that spawn upstream of the barrier dam to salmonid populations in a restored Battle Creek?
2. What level of genetic risk does operation of Coleman NFH and Livingston Stone National Fish Hatchery pose to the genetic integrity of spring and winter Chinook salmon and steelhead in a restored Battle Creek and the upper Sacramento River?
  - a. Is there evidence of hybridization among salmon runs?

- b. Do mating, production, and release strategies increase likelihood that hybridization will occur in a restored Battle Creek?
  - c. Are there alternative mating, production, and release strategies that can reduce risk of hybridization?
  - d. What is genetic composition of wild (naturally spawning) and hatchery steelhead in Battle Creek?
3. What is the level of risk posed by Coleman NFH-origin fall and late-fall run Chinook and steelhead spawning in upper Sacramento River and tributaries compared to the level of risk in Battle Creek? Consider carrying capacity and genetics of upper Sacramento River, and tributaries, and Battle Creek.
  4. What level of biological risk (water quality, disease, carrying capacity) do excess salmon carcasses in Lower Battle Creek pose to salmonid populations in a restored Battle Creek?
  5. What level of disease risk does operation of the Coleman NFH pose to salmonid populations in a restored Battle Creek?
  6. What level of water quality risk (temperature, biological oxygen demand, and other chemical and physical constituents in the effluent) does operation of the Coleman NFH pose to salmonid populations in a restored Battle Creek?
  7. What additional monitoring and research would you recommend to improve adaptive management of Coleman NFH operations with regards to restoration of salmonid populations in Battle Creek?

We also stipulated that the panel should not be constrained to the questions submitted, but to add others as long as they were within the scope of the broad issue of the possible effects of the Coleman NFH on the Battle Creek restoration project.

With the help of the stakeholders and agency representatives, we selected four approaches to providing information to the panel:

- Forwarding hard or electronic copies of important documents (see Appendix A for a list of documents sent to science panel);
- Convening the two-day workshop (see Appendix B for workshop agenda) for presentations and discussion (see Appendix C for attendance list);
- Providing the panel with the power point slides shown at the workshop; and
- Providing for a post workshop tour of the Coleman NFH and the Battle Creek watershed.

The panel also had the opportunity to request additional information after the workshop.

This report follows the agenda and the material has been mostly taken from the presentations and discussion. In a few instances we have added material not presented but which we believe to be important to completing the story. In those cases, we identify the source of the material.

## **Introductory Remarks and Ground Rules**

Wim Kimmerer emphasized that this is technical workshop and not the place to air political issues. He also stressed the need to keep the questions and presentations focused on the workshop topic – that is, the role of the Coleman NFH on restoration of Battle Creek.

## Stakeholder Statements

Although we convened the workshop to examine technical issues, we included a session where representative stakeholders could make relatively brief non-technical statements describing their concerns about Battle Creek restoration as it could be affected by operation of the Coleman NFH. The following represents what we believe to be the speakers' main points.

### The Battle Creek Watershed Conservancy

*Larry Lucas*

The Battle Creek Watershed Conservancy (Conservancy), in part, represents the wide variety of interests in the watershed, much of which is in private ownership and relatively inaccessible to the general public. The watershed contains valuable salmon and steelhead trout habitat. The Conservancy will consider restoration successful when the watershed supports stable populations of target species. Simply increasing in-stream flows is not enough.

One of the Conservancy's primary concerns involves the presence of the Coleman NFH on lower Battle Creek. The Coleman NFH was constructed and has been operated to mitigate for habitat loss associated with Shasta and Keswick dams on the Sacramento River, not habitat loss by federal actions on Battle Creek itself. The Coleman NFH has done reasonably well in meeting its mitigation responsibilities for fall Chinook, not so well with late fall and winter Chinook and steelhead, and not at all for spring Chinook. The Conservancy is concerned that the Coleman NFH barrier dam on Battle Creek adversely affected spring Chinook populations in the watershed by impeding passage, both upstream and downstream. The decline in spring Chinook in the basin was coincidental with installation of the full fish barrier in Battle Creek (Figure 1). The Conservancy is also concerned that the Coleman NFH is continuously expanding its mission, in spite of the fact that its purpose has not been clearly defined.

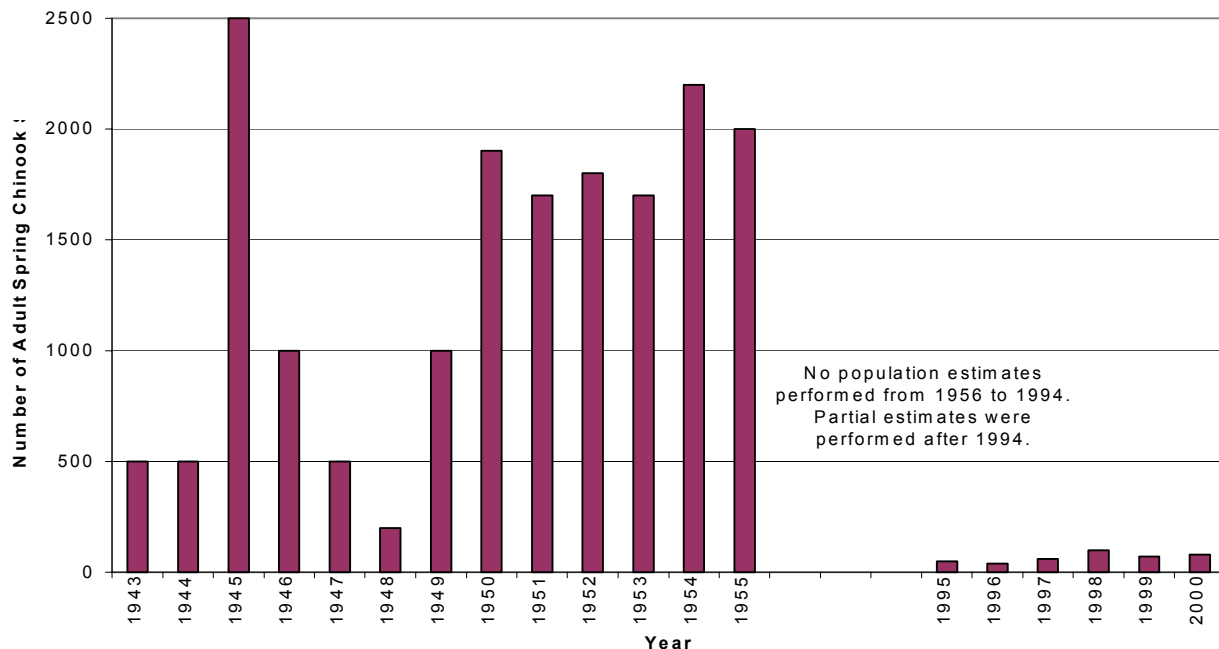


Figure 1. "Reason's for locals' suspicions." Source: Larry Lucas.

The Conservancy has raised the issues about the potential effects of the Coleman NFH on the restoration of Battle Creek at public forums and in a report, "The 1999 Working Group Report on Compatibility of the Hatchery and the Watershed" (Kier Associates 1999). The Conservancy and others applied (unsuccessfully) in 1999 for a Packard Foundation grant to bring their questions before an independent technical panel. Beginning in 2001 the Conservancy then worked with the Science Program in this effort to bring in outside experts to examine the issues.

The Conservancy requests that the panel:

- Assesses the efforts being made to restore Battle Creek as to their effectiveness and comprehensiveness. The Conservancy is looking for critical and defensible science.
- Provides a creative look at the future of Coleman NFH and Battle Creek, without the impediment of policy goals – that is, think "outside the box."
- Considers the seven questions posed to the panel and give top priority to the needs for additional studies – framed in the context of an sound adaptive management program, both for the project and for the Coleman NFH. In this vein:
  - The Conservancy and other stakeholders need to be an integral part of planning and executing an adaptive management program.
  - Critical decisions should not be postponed while designing and discussing the adaptive management plan.

## **Pacific Coast Federation of Fishermen's Associations**

*Bill Kier*

The principal message that the Pacific Coast Federation of Fishermen's Associations (PCFFA) would like to bring to the science panel is to, please, think "outside the box." The CBDA staff, in the case of the just-completed Battle Creek Technical Review Panel, constrained the Panel's inquiry. Don't let that happen to you.

PCFFA makes this recommendation based upon what it sees as a pattern on the part of the CBDA agencies to confine their thinking. At the time that PCFFA joined water interests in launching the extra-governmental Battle Creek Working Group (BCWG), the agencies were busy fitting out the 100-year-old Battle Creek Hydroelectric Project dams - all of them - for new taxpayer-provided screens and ladders. It took the outside-the-box thinking of the new BCWG - the extra-governmental group - to produce the dam-decommissioning January, 1999 Battle Creek Salmon and Steelhead Restoration Plan, the basis for the CBDA's Battle Creek Restoration Project.

As the BCWG handed off its Plan to the responsible agencies to implement, it turned its attention to lower Battle Creek and the relationship between Coleman NFH operations and the proposed restoration of the watershed's naturally-spawning salmon. This led to the BCWG's March, 1999 report Maximizing Compatibility between Coleman National Fish Hatchery Operations, Management of Lower Battle Creek, and Salmon and Steelhead Restoration, the "Compatibility Report." The Compatibility report called out the potential conflicts between Coleman operations and the proposed restoration project and it suggested some outside-the-box solutions, including shifting some of Coleman's production to Livingston Stone National Hatchery.

The BCWG's proposals for Coleman are unpopular with the CBDA agencies. It has been nearly five years since they were proposed and in those five years the USFWS has led four failed attempts to provide a scientific review. The Battle Creek Watershed Conservancy's attempt to raise funds with which to evaluate the report's proposed alternatives to business-as-usual at Coleman was squelched by the CBDA agencies.

There is something clearly threatening about the “Compatibility” report. PCFFA commends it to your reading. It is only 37 pages long.

PCFFA recommends, as well, that your Science Panel study the just-released CBDA Technical Review Panel report, particularly Section 7.0, in which, in its one brief escape from the CBDA box, the Panel notes that the biological objectives of the Battle Creek restoration project could better achieved, likely at less public cost, through alternative approaches. The need for honest review of alternative approaches applies equally to the operations of Coleman National Fish Hatchery. PCFFA wishes you godspeed with your inquiry.

## **Metropolitan Water District of Southern California**

*Walt Hoyer*

The Metropolitan Water District of Southern California (MWD) promotes water supply reliability and water use efficiency through water conservation and recycling programs. Since a significant portion of MWD’s water supply originates in the Central Valley, healthy populations of Central Valley native fish species are essential to the reliability of water from this source.

In December 1994 several agency and stakeholder groups signed the 1994 Bay-Delta Accord. The Accord signatories were looking for a truce in the long-standing water wars and agreed to:

- Create the CALFED Bay-Delta Program to work towards achieving the dual goals of restoring the Central Valley and San Francisco Estuary ecosystem and increasing water supply reliability.
- Create interim environmental protection measures (so-called Categories I and II) and to promote non-flow related measures that would improve aquatic habitat – called the Category III Program. Category III measures included activities like habitat improvement (for example, streambed restoration), improving or installing screens to water diversions, improving fish passage at barriers, reducing the impacts of waste discharge and through artificial propagation of target species (for example, the winter Chinook captive broodstock program.)

To help make the Category III Program a success, MWD committed \$30 million as seed money and worked with the agency and stakeholder communities to solicit, select, fund and monitor projects. Through this cooperative effort, MWD eventually selected and funded 47 projects (Figure 2).

Included in the funded projects, are the following five projects dealing directly with Battle Creek.

- Engineering investigation of fish passage in upper Battle Creek.
- Chinook salmon and steelhead restoration study.
- Establish watershed conservancy.
- Winter Chinook broodstock program and spring Chinook genetics study.
- Provide five-year funding (approved in 2003) to the Conservancy to hire Mike Ward to work with agency and stakeholder biologists and managers to help sort out issues concerning Battle Creek restoration.

MWD continues to believe that Battle Creek restoration is one of the most important, if not the most important, projects in the Central Valley. MWD further believes that:

- Absent Coleman NFH representing a fatal flaw to Battle Creek restoration, the restoration projects should be implemented as soon as possible, with Coleman NFH improvements proceeding concurrently.
- The project should be phased – that is, the project should use the incremental approach.
- Battle Creek, Clear Creek, and Butte Creek projects should be used as examples of how restoration can be accomplished.
- Removing all hydropower facilities in the watershed is not practical.
- We need an effective and comprehensive adaptive management framework.
- The Coleman NFH operation needs to be held to the same standards as Battle Creek restoration.
- Project delays increase the risk of failure.

In summary, MWD asked the science panel to look for any fatal flaws in the Battle Creek Restoration Program, and barring none, to recommend that the program move forward.

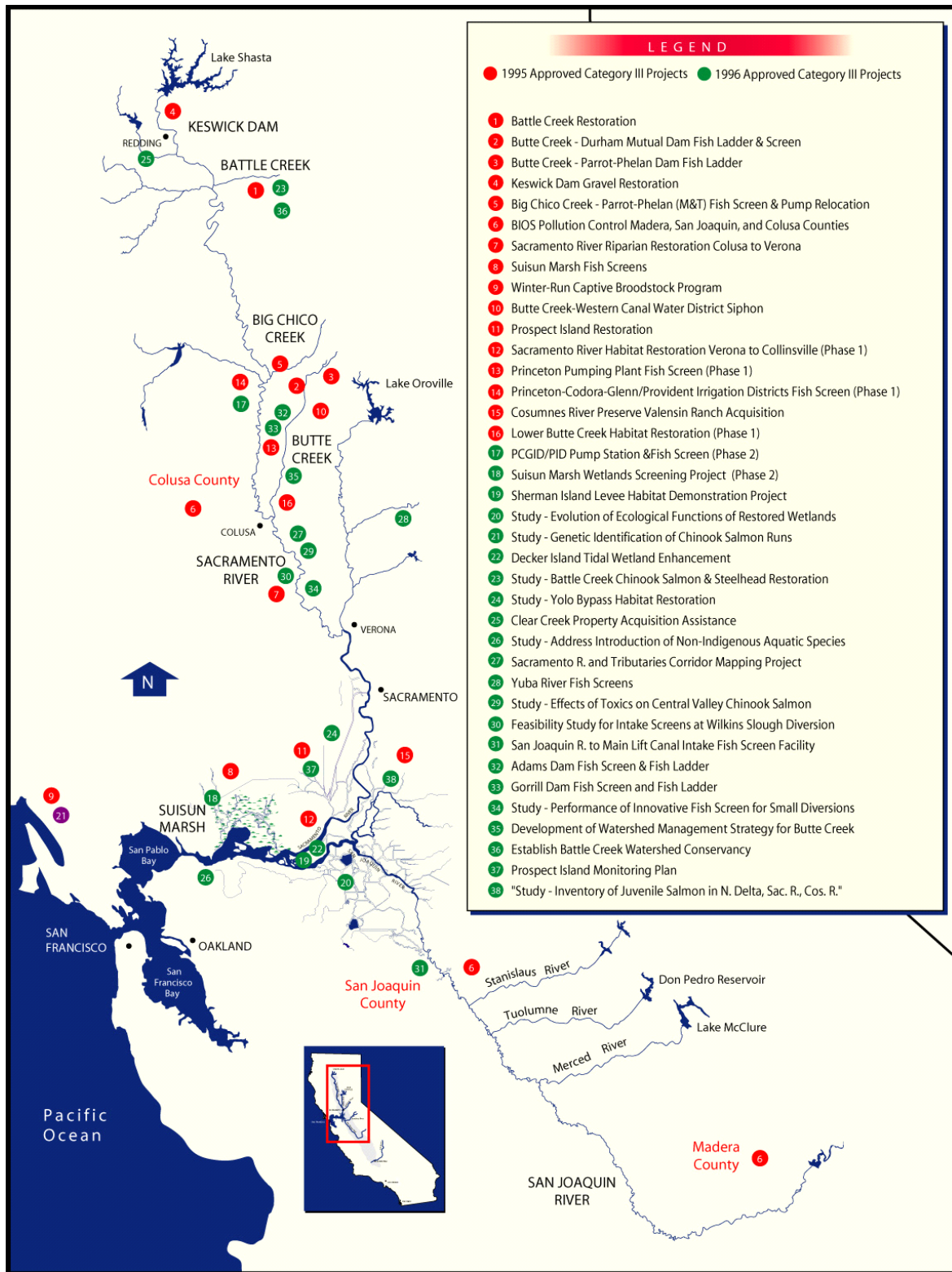


Figure 2. Category III projects through 1996. Source: Walt Hoye.



## **Central Valley Project Water Users Association**

*Serge Birk*

Although there is a fair amount of uncertainty in the Battle Creek Restoration Project, the Central Valley Project Improvement Act (CVPIA) and the CALFED Bay-Delta Program have invested tens of millions of dollars in the project – a project that is consistent with CVPIA and Ecosystem Restoration Program goals. Battle Creek is a unique resource and its restoration, through a suite of actions, may be precedent setting. The Central Valley Project Water Users Association (CVPWUA) is concerned, however, about the apparent lack of a long-term commitment by the implementing agencies.

The CVPWUA is also concerned about the hatchery's connection to the restoration project and that hatchery management and staff are not being entirely open to the world. There are several significant problems involving the hatchery and the restoration project:

- The hatchery barrier weir.
- The large numbers of fall Chinook returning to lower Battle Creek and the hatchery – fish which might be redistributed in the restored watershed.
- The genetic risks of steelhead and salmon supplementation programs in the watershed.
- The effects of sediment loads generated by the restoration project on the hatchery.
- Water quality impacts of large spawner biomass on lower Battle Creek.

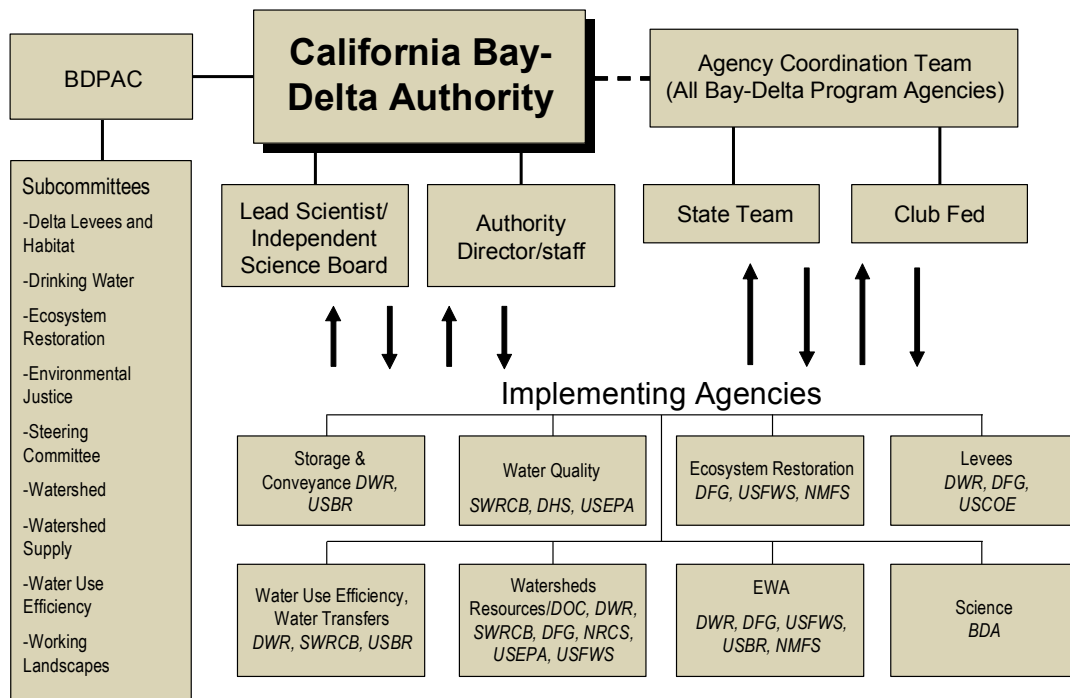
The CVPWUA is also concerned about the lack of recovery strategy in the restoration program. Once the recovery strategy is developed, it needs to be accompanied by a monitoring program as part of an adaptive management framework. For example, interim stream flows were augmented at a cost of about \$2 million dollars. There wasn't adequate monitoring to evaluate the benefit of these flows. Likewise there is little evidence of adaptive management in the current restoration plan. The agencies may not have the technical nor financial capabilities to carry out an adaptive management plan.

Finally, continued, and even expanded, stakeholder involvement is key to successfully restoring Battle Creek's unique and valuable habitat.

## **California Bay-Delta Authority**

*Dan Castleberry*

The California Bay-Delta Authority (CBDA) is responsible for overseeing and coordinating implementation of the CALFED Bay-Delta Program, and for implementing the Science Program. The CBDA is an agency within the State of California government and includes federal participation. The CALFED Bay-Delta Program structure is shown in Figure 3. Funding for the Battle Creek Restoration Program is from the Ecosystem Restoration Program (ERP), one of the Bay-Delta Program elements. The Science Program, another Bay-Delta Program element, is sponsoring this workshop with assistance from the ERP.



**Figure 3. CALFED Bay-Delta Program governance structure. The Ecosystem Restoration and Science program elements are shown in the lower right corner under Implementing Agencies. Source: Dan Castleberry. (Note: This slide was not shown at the workshop.)**

Workshops and expert panels are among the tools the Bay-Delta Program uses to help resolve difficult technical issues. This workshop is to focus on the role and impacts of Coleman National Fish Hatchery on the potential of habitat restoration efforts on Battle Creek. The ERP recognizes the importance of the hatchery for its role as a mitigation facility and in helping to maintain Chinook salmon and steelhead fisheries in the Bay-Delta system. The ERP also recognizes the potential of a restored Battle Creek to support winter-run and spring-run Chinook salmon and steelhead, and has made significant investments to support the restoration effort. The ERP is committed to supporting a solid scientific foundation for the project and fish management in Battle Creek and other Central Valley watersheds.

The ERP recently sponsored a technical review of the restoration project. Workshop Panel members have this review. The ERP continues to consider the restoration project as a directed action, and looks forward to the project managers response to the project review as well as any comments that the workshop panel might make pertaining to the restoration project.

To date, the Bay-Delta Program has not reviewed fish management or potential effects of the hatchery on a restored Battle Creek, the focus of this workshop. We are looking to focus on technical issues here today, with the help of the distinguished panel and presenters, as well as members of the audience.

The Bay-Delta Program is looking to this panel for answers to the set of questions included in the agenda for this workshop. We are also asking the panel for a sense of priority among the critical issues that the panel might identify as they address the questions. We expect that this workshop and the panel's report will change the nature of the debate, helping all involved to focus on the important issues facing management and restoration of fish and their habitat.

## Technical Presentations

The presentations were designed to provide the science panel with an overview of several aspects of Battle Creek, the restoration plan, and the hatcheries, mostly about the Coleman NFH, but including some information on the Livingston Stone NFH. Each presentation summary is followed by questions and answers resulting from that presentation, and at times, from a previous talk.

### An Overview of the Battle Creek Watershed

*Michael Ward, representing the Battle Creek Watershed Conservancy*

Ward briefly described his five years of experience working in the Battle Creek watershed, ranging from co-authoring the adaptive management plan, restoration, and compatibility reports to a hands-on watershed assessment. The Battle Creek Watershed Conservancy recently received a five year Category III grant from MWD to continue his work for the Conservancy. Much of the material in his presentation is from the watershed assessment and should be considered preliminary until the project report is released sometime before the end of 2003. Ward will provide a copy of the draft report to the panel.

The Battle Creek watershed (Figure 4) has several demographic and geographic features that relate to its potential importance to anadromous Chinook salmon and steelhead trout:

- The stream has considerable groundwater accretion and this groundwater can yield a base flow of around 250 cubic feet per second (cfs) of cold water, even during dry years. (See Figure 5 for the annual average hydrograph and Figure 6 for a stream temperature profile.)
- The stream network starts at about 10,000 feet on the slopes of Mt. Lassen and in about 30 miles drops to 300 feet, thus creating a variety of habitat.
- About 60% of the watershed is in private ownership, thus limiting access and creating a protective buffer around stream channels.
- A relatively small portion (around 4%) of the watershed is in industrial timber.

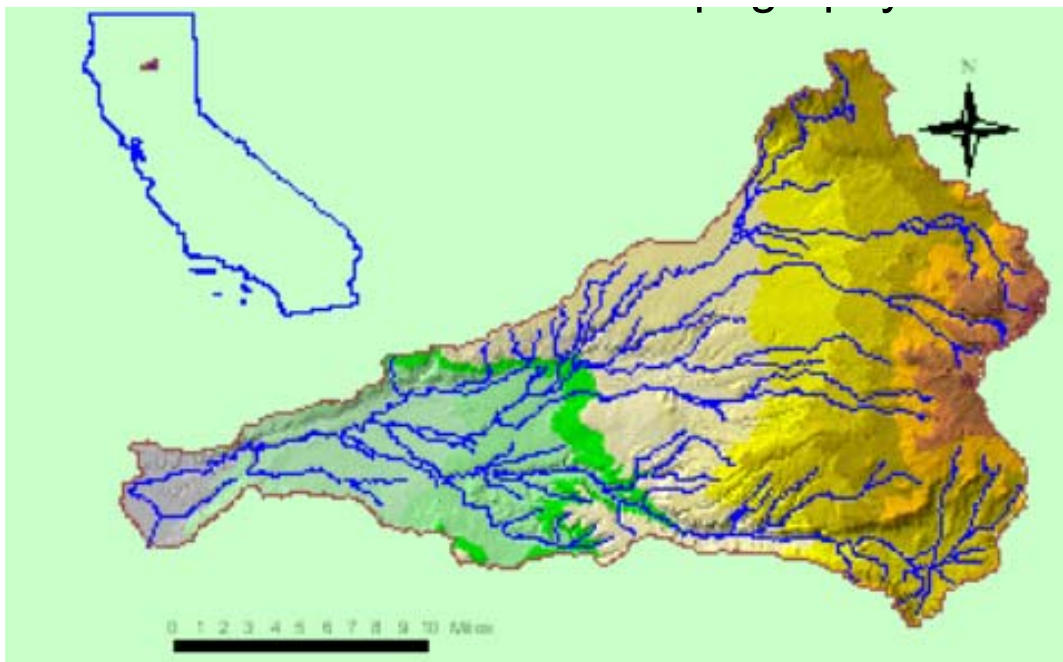


Figure 4. Location and topography of the Battle Creek watershed. Source: Michael Ward.

The stream characteristics lead biologists to focus on the relative potential for high over-summer flows and cold temperatures and the salmonid species that most benefit from these conditions: winter and spring Chinook and steelhead trout. Ward pointed out that the South and North forks exhibit differences in their ability to support salmonids, mainly because the South Fork is more exposed than the North Fork.

There is a wealth of information regarding the Battle Creek watershed, much of it coming from his new watershed assessment. As mentioned earlier, the assessment, which is based on information collected from 50 randomly selected sites in the watershed, is in draft form and should be released by the end of 2003.

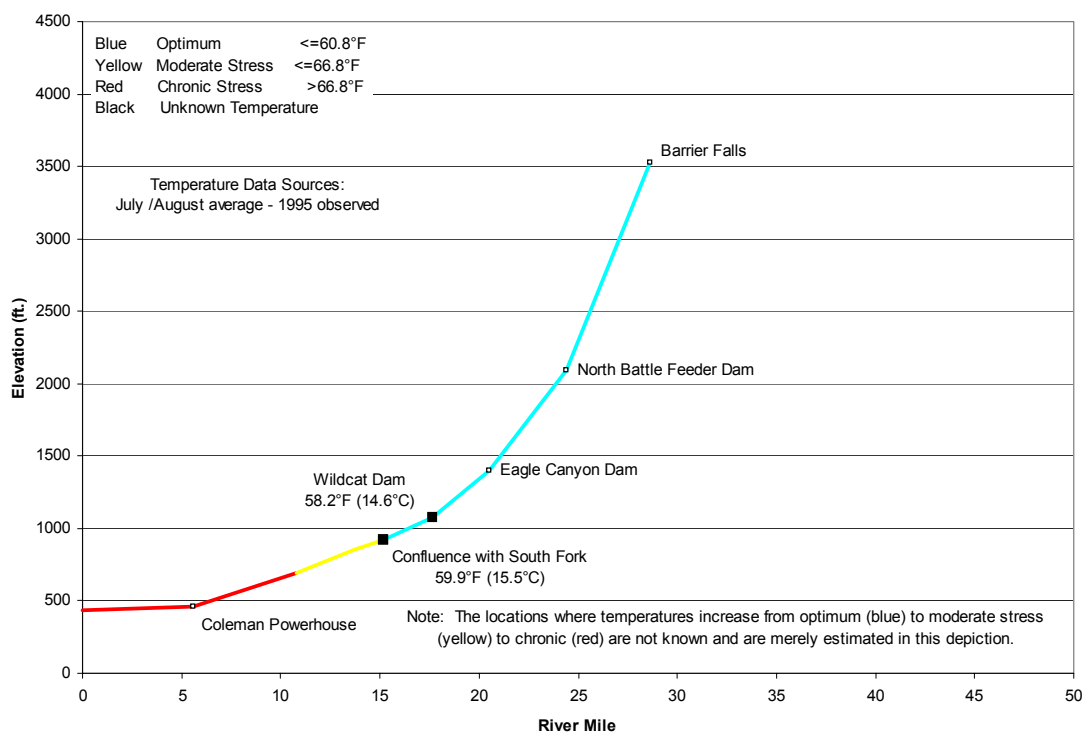


**Figure 5. Average annual hydrograph of the Battle Creek watershed. Source: Michael Ward.**

Ward did offer a few preliminary observations based on analysis of study data using AREMP and EMDS analytical procedures, Rosgen channel morphology, substrate (d50, fines), pool frequency and depth, and the community of benthic macro-invertebrates.

- Areas suitable for salmonid spawning – based on particle size – are relatively scarce.
- There are not many pools in the system - fewer than may be best for holding pre-spawning winter and spring Chinook.
- Macro-invertebrates communities indicate that the stream is healthy.

Ward emphasized that the 1997 flood had a significant impact on the system and that much has changed since surveys conducted in the 1980s. The stream will recover as sediment passes through the watershed. Ward also emphasized that, in his professional opinion, in-channel conditions are not a limiting factor due more important limiting factors (dams/flows) and due to the existing low abundance of target populations. These populations may take 10-20 years to recover under the restoration project. Currently depressed conditions will likely recover, absent major storms, before salmon and steelhead populations expand to a point where in-channel conditions could limit their populations.



**Figure 6. Average summer (July and August) water temperatures in the North Fork of Battle Creek, based on TRPA-SNTEMP output and 1995 observed data. Source: Michael Ward.**

Questions from the panel:

- Q: Do you have comparable data from Mill, Deer, and Butte creeks? Since these streams have recently supported relatively high runs of spring Chinook, these data could be used to help assess the importance of any apparent gravel or pool limitations in the Battle Creek watershed.
- R: Ward and the audience were not aware of any comparable data but agreed that such a comparison would be useful.
- Q: Is the upper Battle Creek watershed protected?
- R: A small part of the upper Battle Creek watershed is managed by the U.S. Forest Service and Sierra Pacific, both of whom are taking steps to reduce sediment delivery and both of whom operate within existing timber harvest regulations that are intended to be protective. Roads have been identified by the USFS to be a significant source of sediment.

## **The Proposed Battle Creek Restoration Project**

*Harry Rectenwald, Dept. of Fish and Game*

There has been a long history of interest in Battle Creek restoration, beginning in the 1980s. Senate Bill 1086 was one of the first efforts to focus on restoration activities in the Upper Sacramento River and listed 20 actions, including a temperature control device on Shasta Dam and restoration of Battle Creek – actions to recover depleted salmonid populations. Even with the temperature control device installed, temperature model simulations indicated that there would still be three years out of every hundred when summer temperatures in the winter Chinook holding, spawning, and rearing grounds in the upper Sacramento River

would be lethal to Chinook eggs. There would be another ten years when temperatures would cause serious problems.

In 1989 there was a collaborative study of Battle Creek to look at water temperatures, species presence and abundance, and the barrier. The results of this study indicated that there were cold water refugia in the watershed but they were not always connected. One of the problems with this and subsequent studies is the lack of precise water temperature data and daily water temperature models. In spite of this limitation, Battle Creek became one of the key elements in the list of actions to recover winter Chinook.

The overall goal of the Battle Creek restoration project is to develop genetically viable, self-sustaining salmonid populations which would get the populations through a prolonged drought. *(Authors' note: In reading descriptions of the Battle Creek Recovery Project in several documents, the stated goals are generally not specific as to the target species and definitions of the terms viable and sustainable populations. It appears that the target races and species may be in two tiers: Tier 1 contains winter and spring Chinook and steelhead trout and Tier 2 contains fall and late fall Chinook. There are no quantitative goals for numbers of adults or juveniles, although a working paper for the CVPIA's Anadromous Fisheries Recovery Plan provided the following estimated numbers of spawners (based on habitat availability): winter and spring Chinook, 2,500; fall and late fall Chinook, 4,500; steelhead trout, 5,700.)* Additional goals were to create a reliability and stability in a properly functioning ecological and hydropower systems. Achieving these goals required community involvement and acceptance.

Developing the Battle Creek restoration plan has involved the public at almost all planning phases. Before the Federal Energy Regulatory Commission (FERC) re-licensing process in the 1970s much of the stream flow was captured by the hydroelectric project and the system was leaky. The water conveyance and powerhouses were modernized under the current license due expire in 2026. Through early re-opening of the FERC re-licensing process, five alternatives are being considered involving flows, facilities and water rights. The alternative selected will leave some dams in place but, in all cases, will add water back into the system and generally increases base flows by up to ten times. When dams remain, they will have new fish ladders and screens.

The restoration plan is designed to provide critical refugia, connectivity and flow stability with the negotiated flows making 95% of the usable habitat available to anadromous salmonids. With the present adult spawning population levels (on the order of 10 winter Chinook, 100 spring Chinook and 1000 steelhead spawners annually) it may take decades to reach goal of genetically viable, self-sustaining populations. The project will require a rigorous, effective monitoring. Although there is a \$3 million contingency fund, this money is not dedicated to monitoring.

With regard to the hatchery, the science panel should list any concerns in order of priority and indicate if the project should be delayed while addressing the top priority concerns or if the project can proceed while the concerns are being addressed.

## **An Overview of Coleman and Livingston Stone National Fish Hatcheries**

*Scott Hamelberg, U.S. Fish and Wildlife Service*

Coleman NFH and Livingston Stone NFH are part of a complex of federal and state hatcheries located in the Central Valley (Figure 7). These hatcheries have been constructed and operated to mitigate for habitat lost when upstream dams blocked access to historic salmonid spawning grounds. On average, the



Central Valley hatcheries annually release a combined 37 million juvenile salmonids, mostly at the smolt stage.



**Figure 7. Coleman NFH: Constructed in 1942 to partially mitigate for the impacts of Shasta Dam (about 187 miles of lost habitat). Source: Scott Hamelberg.**

Coleman NFH was constructed in 1942 to partially mitigate for habitat lost due to the construction of Shasta Dam. The Battle Creek site was selected because of the presence of a good water supply and the fact that there had been successful fish culture operations on Battle Creek since 1895. There was also concern about water quality problems on the upper mainstem Sacramento River.

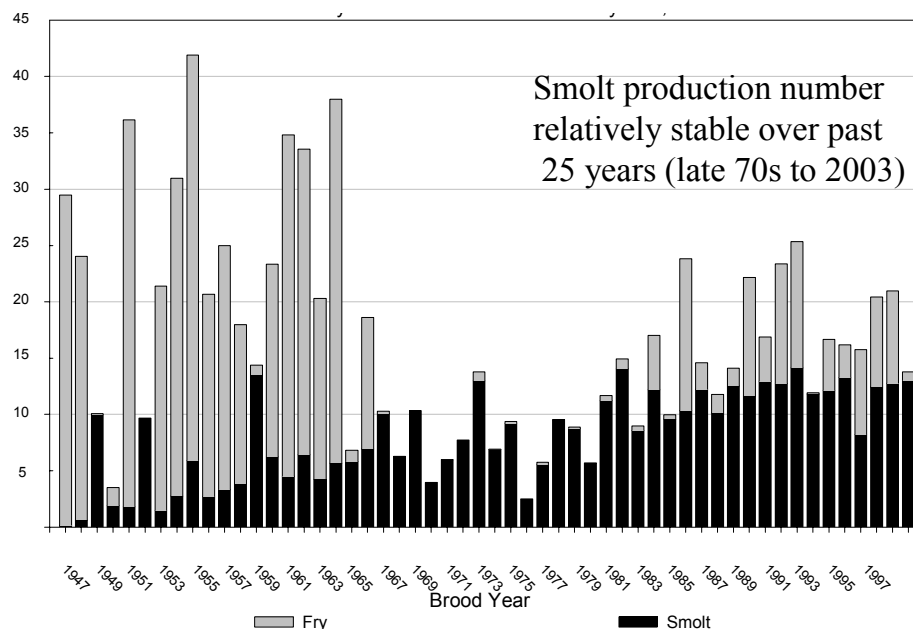
The hatchery itself is located on about 75 acres near mile 11 on Battle Creek and consists of the following principal features:

- Barrier weir and fish ladders
- Spawning building
- Tank house and juvenile rearing ponds
- Ozone water treatment plant – the largest ozone plant on any fish culture operation in the world
- Pollution abatement ponds
- Water supply intakes

The following outlines the production purpose and goals for individual species and races reared at the Coleman NFH.

*Fall Chinook.* Annual production of about 12 million smolts as mitigation for Shasta Dam and to help preserve this important run in the upper Sacramento River. Returns from hatchery releases contribute to the ocean sport and commercial fisheries and the in-river sport fishery. Although there are some experimental in-river fry releases, the past practice of releasing “surplus” fry was discontinued in 1998. Except for experimental releases, all fall Chinook hatchery production is released in April on station. Figure 8 shows the numbers of smolts and fry released during the period 1947 to 1998. Smolt production has been relatively stable over the past 25 years through 2003. In the past two years, none of the fall Chinook

production has been coded wire tagged. Until that time, there have been some releases of coded wire tagged fish every year for about the past 25 years.



**Figure 8. Number of fall Chinook salmon released from Coleman NFH into the Sacramento River system, 1945–1997. Source: Scott Hamelberg.**

*Late fall Chinook.* About one million late fall smolts are released each year as mitigation and as experimental releases (Figure 9). In recent years many of the experimental fish have been used as surrogates for spring run juveniles (upstream releases of marked fish) and to estimate Delta pumping impacts on through-Delta survival of juvenile winter, spring, and late fall Chinook (Delta releases.) Production fish and spring run surrogate experimental groups are released in the upper Sacramento River from November through January. All late fall production is coded wire tagged and individual tag codes are used to separate experimental from production releases.

*Steelhead Trout.* The hatchery goal is to raise and release 600,000 steelhead smolts annually. As shown in Figure 10, in recent years the hatchery has met this goal. Juvenile steelhead are released in the upper Sacramento River, generally during January. Since 1995, CHFH staff has been allowing some adult steelhead to pass the barrier weir into the upper Battle Creek Watershed. Since broodyear 1998 all juvenile steelhead releases have adipose clips.

*Winter Chinook.* In 1998, the USBR began operating the Livingston Stone NFH specifically to rear winter Chinook. (For several years previously, winter Chinook had been reared at the Coleman NFH but the adults tended to return to Battle Creek, not to the mainstem Sacramento River as intended.) As indicated in Figure 11, the hatchery is approaching its goal of releasing about 250,000 into the upper Sacramento River below Keswick Dam. In 2002, about 235,000 winter Chinook smolts were released into the upper Sacramento River. All winter Chinook releases are coded wire tagged.

*Spring Chinook.* Early attempts to hold, spawn and culture spring run at Coleman NFH were unsuccessful and this race is not reared.



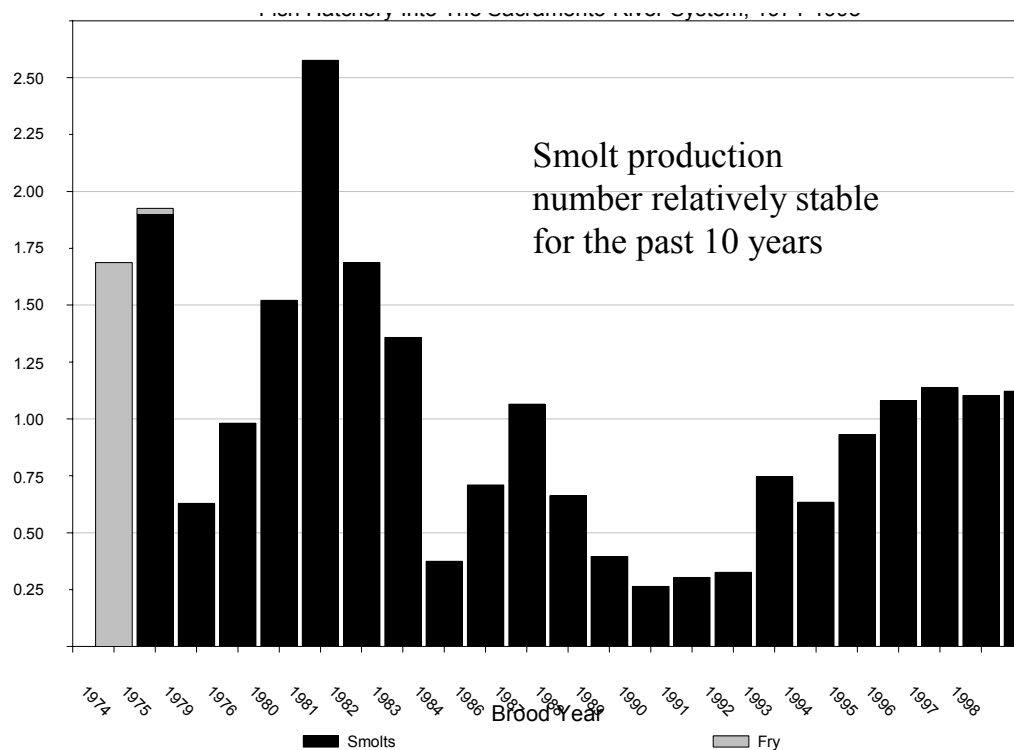


Figure 9. Number of late fall Chinook salmon released from Coleman NFH into the Sacramento River system, 1974–1998. Source: Scott Hamelberg.

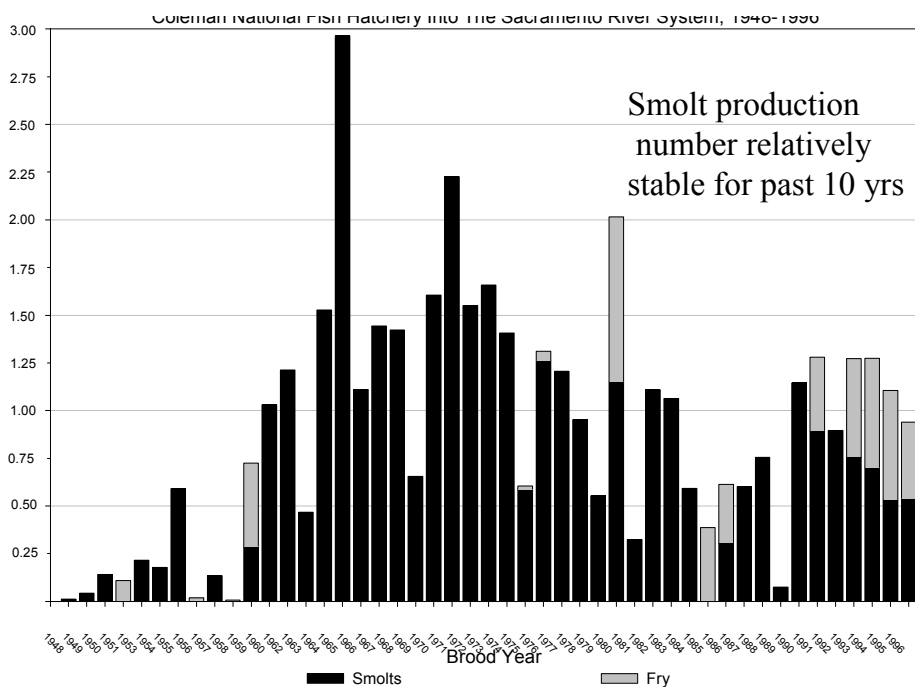
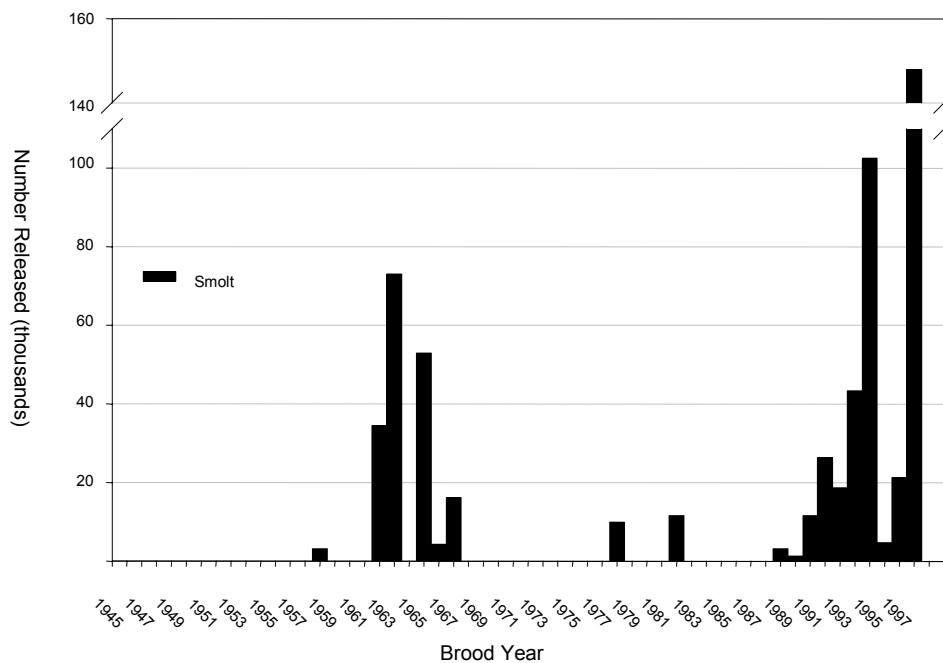


Figure 10. Number of steelhead rainbow trout *O. mykiss* released from Coleman NFH into the Sacramento River system, 1948–1996. Source: Scott Hamelberg.



**Figure 11. Number of winter Chinook salmon released from Coleman NFH into the Sacramento River system, 1945–1997. Source: Scott Hamelberg.**

The overriding goals of Coleman NFH are to achieve mitigation, experimental, or restoration and recovery objectives, while minimizing impacts on remaining natural fish populations. The following provide the legislative mandate for minimizing impacts on salmonid populations – all of which are listed or are candidates for listing under the federal Endangered Species Act.

- **Federal Endangered Species Act:**
  - Legislatively required to minimize impacts to listed species.
  - ESA Section 7 and 10 coordination and consultation with NOAA Fisheries
  - USFWS shares ESA regulatory functions
- **California Endangered Species Act:**
  - Cooperate with the California Dept. of Fish and Game (DFG)
- **Central Valley Project Improvement Act (legal mandate to operate and rehabilitate Coleman NFH):**
  - Anadromous Fish Restoration Program (AFRP), one component of the CVPIA. The objective of the AFRP is to increase the abundance of naturally produced salmonids. The USFWS and USBR are agency managers of the AFRP. The AFRP provided the basic template for Battle Creek restoration.

All stocks reared at Coleman are part of the federally designated Evolutionarily Significant Unit (ESU). Hamelberg listed the following actions being considered for minimizing the effects of Coleman NFH on naturally spawning salmonid stocks.

- Assessment programs to evaluate means of reducing impacts on natural stocks.
  - Requires marking and tagging

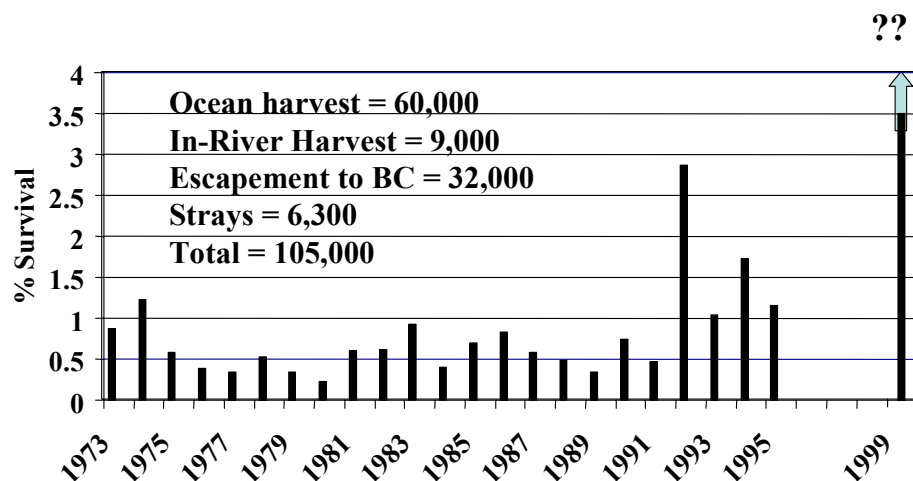
- Continue coordination and consultation with regulatory agencies (DFG, NOAA, Central Valley Regional Water Quality Control Board)
- Proactive process to modify structure and operation of the barrier weir
- Proactive efforts to screen and modify water intakes

As summarized in Table 1, estimated actual survival (averaged over a number of specific years) has generally been less than the target for salmonid species and races reared at Coleman NFH and Livingston Stone NFH.

In spite of not meeting the target survival rate, fall Chinook have been returning to Battle Creek in relatively high numbers (Figure 12) and making a significant contribution to the ocean and inland fisheries.

**Table 1. Target and estimated survival to adult of all four races of salmonids reared at Coleman and Livingston Stone national fish hatcheries**

<i>Species</i>	<i>% Smolt to Adult Survival Target</i>	<i>% Estimated Performance Average (SD)</i>	<i>Years Analyzed</i>
Fall Chinook	1.0%	0.78 (0.56)	1973 – 1995
Late Fall Chinook	1.0%	0.83 (0.47)	1989 – 1995
Steelhead Trout	0.5%	0.32	1991 – 1994
Winter Chinook		0.72 (0.62)	1991 – 1995



**Figure 12. Estimated percent survival of Coleman NFH fall Chinook salmon, broodyears 1973–1995. Source: Scott Hamelberg.**

(Note the extremely high survival and returns for the 2002 escapement were probably due to good conditions in the ocean.) Further, Hamelberg provided the following estimates for the contribution of the Coleman NFH's fall run production to the ocean fisheries:

- 1975 – 1998 = 14% of harvest (23 years)
- 1990 – 1998 = 20% of harvest (9 years)

No explanation was given for the increased contribution in the 1990s.

In summary, the Coleman NFH will continue fulfilling its mitigation obligations and provide substantial state-wide economic benefits. Any increase in the evaluation program will require a substantial increase in marking and tagging. Hatchery staff will also continue outreach efforts to promote environmental awareness. For example, the facility attracts around 80,000 visitors annually to view the salmon, tour the facilities and receive information about the hatchery, the fish, and their ecosystem. The “Return of the Salmon Festival (held October 18, 2003) attracted over 11,000 visitors during the one-day event.

Questions from the panel:

- Q. Has anything changed since the Biological Assessment was released?
- R. The steelhead supplementation program.
- Q. Have mitigation goals been quantified?
- R. No. Although calculations by a USFWS biologist indicated the hatchery had not fully mitigated for Shasta Dam.
- Q. How did the original planners decide to build the hatchery of a certain size without having quantitative goals?
- R. The hatchery was built to obtain and handle 58 million eggs.
- Q. Why target 30,000 adult fall Chinook escapement to Battle Creek if you only need 10,000 spawners?
- R. 30,000 guarantees we will get the 10,000 spawners entering the hatchery. Not all fish entering Battle Creek ascend the fish ladders to the adult holding ponds.
- Q. What percent of fish are marked?
- R. All steelhead, adipose clip only; all late fall; all winter; for 25 years tagged some fall Chinook each year, but none the past two years.
- Q. How are you trying to minimize interactions with naturally spawning fish?
- R. For fall Chinook by releasing production in April – typically on the backside of the natural smolt migration. Additionally a number of years ago we discontinued the practice of releasing fall Chinook fry.
- C. This is not minimizing, it is reducing to some level.
- Q. Why release winter Chinook as pre-smolts?
- R. We want them to spend some time in the upper river, thus imprinting on this part of the system. Monitoring to date suggests contribution has been favorable under the existing release strategy.

### **Recent Status of Chinook Salmon and Steelhead in the Central Valley and Battle Creek** *Robert Null, U.S. Fish and Wildlife Service*

The Coleman NFH evaluation program is distinct from operation of the hatchery itself. The objectives of this presentation to the science panel and other attendees are to:

- Provide escapement information for Chinook salmon and steelhead in Battle Creek
- Describe the origin of salmonids in Battle Creek (for example, hatchery vs. natural)
- Discuss stray rates into Battle Creek from salmonids produced at other Central Valley hatcheries

- Provide escapement information for Chinook salmon in other Upper Sacramento River tributaries with emphasis on the magnitude of straying of Coleman NFH produced salmonids.

For those fish spawning in Battle Creek, Null provided the following information by race or species.

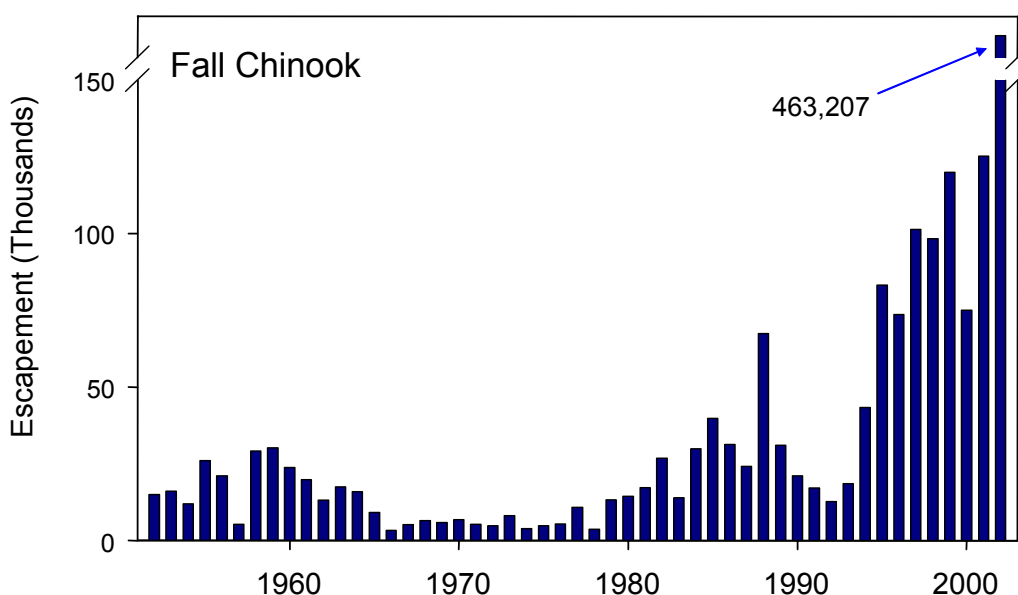
*Fall Chinook.* Figure 13 illustrates the estimated escapement to Battle Creek for the past several years. **(Authors' note: The estimates for 2002 have very wide error bars and it isn't clear how many fish were actually in the stream – other than a lot. Although this caveat is true for all years, it must be kept in mind especially for 2002.)** Spawning numbers have been high the past few years. Mark-recapture information from 2001 and 2002 indicated most of the spawners were direct returns from earlier Coleman NFH releases.

*Late fall Chinook.* As shown in Figure 14 late fall returns have been relatively stable over the past decade and essentially all the fish are of direct hatchery origin.

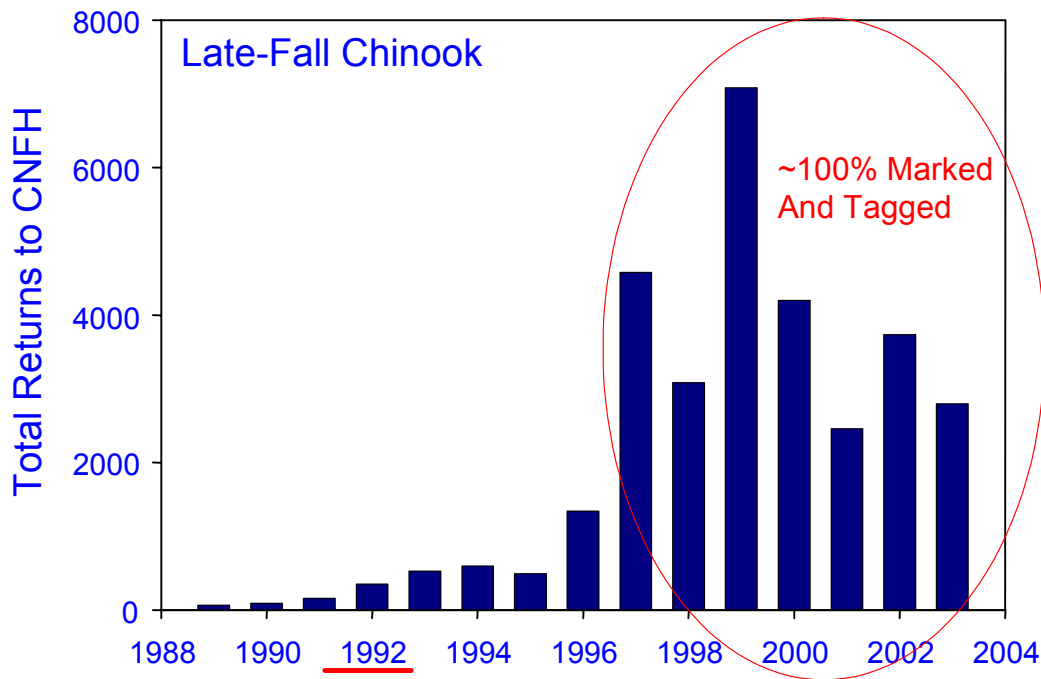
*Winter Chinook.* Very few winter Chinook are now spawning in Battle Creek (Figure 15), and the numbers of winter run spawning in Battle Creek has decreased to near zero since the program was moved to Livingston Stone in 1998.

*Spring Chinook.* Although Figure 16 indicates a slight increase in the numbers of spring Chinook spawning in Battle Creek, Null cautioned that some of these fish may be late falls.

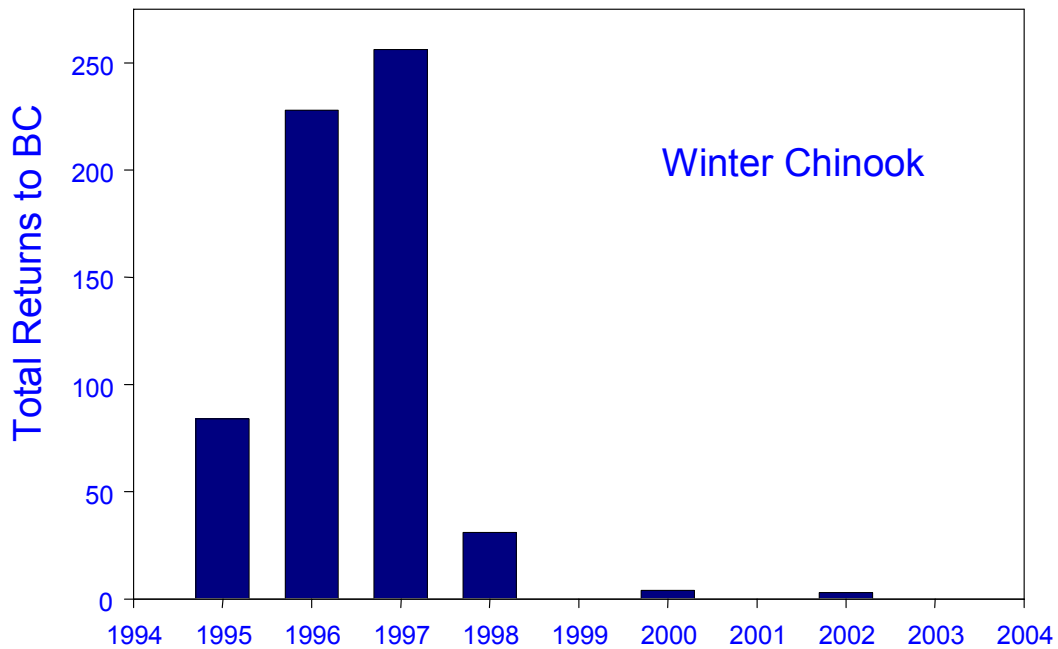
*Steelhead.* As a result of their threatened status, all steelhead in the Central Valley are marked with an adipose clip. Hatchery recoveries of adult steelhead (Figure 17) can be used to demonstrate that most of the fish are of direct hatchery origin. Also as shown, fish passed above the fish barrier, for the supplementation program, are mostly hatchery fish. **(Authors' note: Since all CV steelhead are marked only with an adipose clip, the marked fish could have originated at other hatcheries rearing steelhead, for example, Feather River or Nimbus hatcheries. However it is more likely that the fish are from Coleman NFH.)**



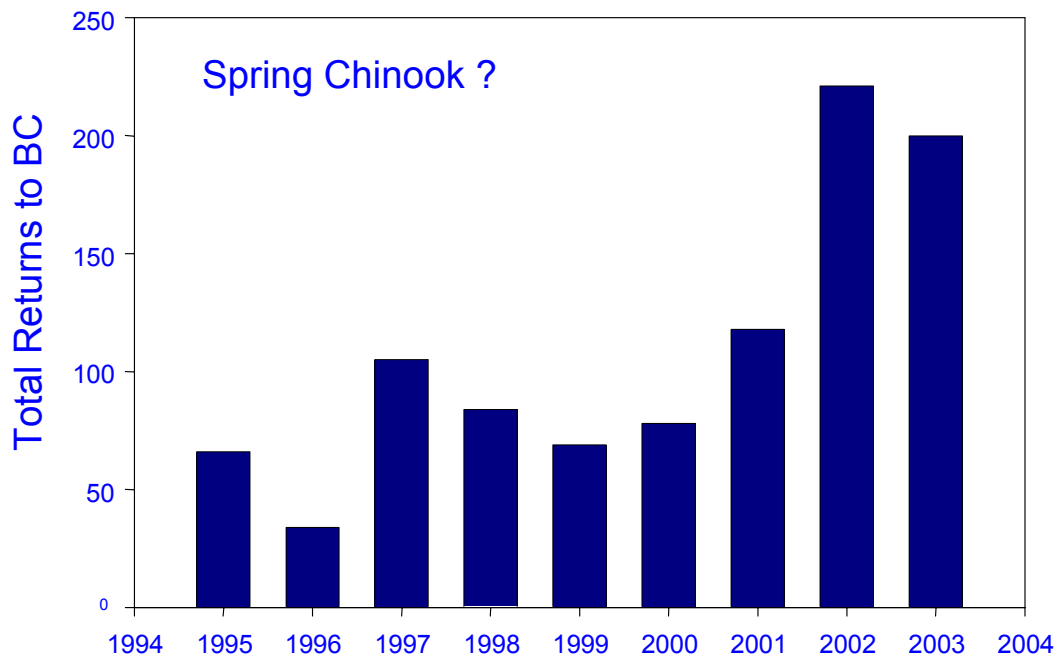
**Figure 13. Escapement of fall Chinook salmon to Battle Creek, Calif., from 1952 through 2000. Source: DFG Grand Tab.) Estimates include both adults taken into Coleman NFH and spawning naturally in Battle Creek. Source: Robert Null and Kevin Niemela.**



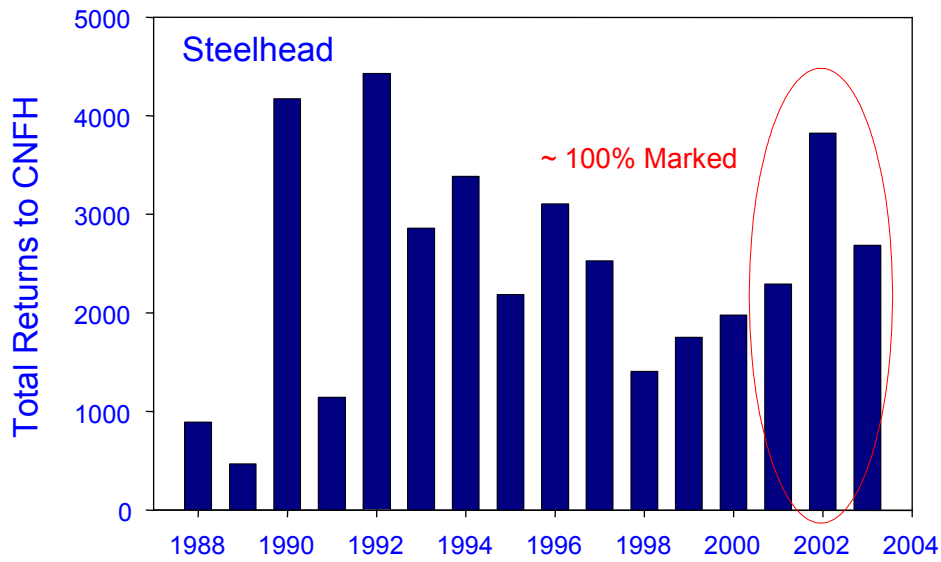
**Figure 14. Total numbers of late fall Chinook salmon collected at Coleman NFH, return years 1969–2003. Source: Robert Null and Kevin Niemela.**



**Figure 15. Estimated numbers of winter Chinook salmon returning to Battle Creek, return years 1989–2003. Source: Robert Null and Kevin Niemela.**



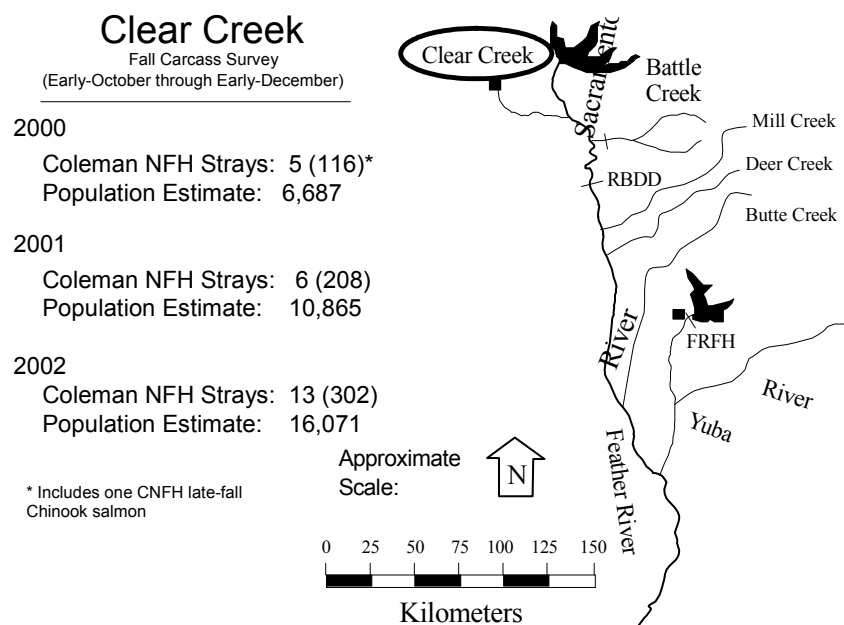
**Figure 16. Estimated numbers of spring Chinook salmon returning to Battle Creek, return years 1989–2003. Source: Robert Null and Kevin Niemela.**



**Figure 17. Total number of steelhead collected at Coleman NFH, broodyears 1989–2003. Source: Robert Null and Kevin Niemela.**

To estimate the rate at which Coleman NFH released juvenile salmonids return to other streams as adults, the hatchery evaluation crew examined the numbers of tags collected in the upper Sacramento River and in several tributaries. Figure 18 illustrates the numbers of fish collected in one of these streams (Clear Creek) and the percentage that was of Coleman NFH origin. In most cases, the numbers of Coleman NFH origin fish found in other streams were lower than those shown for Clear Creek. For example, no Coleman

NFH fish were found in Butte Creek in 2001 or 2002. In general not many Coleman NFH tagged adults are recovered south of the Feather River and those that are come mostly from off-station experimental releases.



**Figure 18. Clear Creek fall carcass survey (early October through early December). Source: Robert Null and Kevin Niemela.**

Null concluded his presentation with the following points:

- There is a trend of increasing abundance of fall Chinook salmon in Battle Creek since the early 1980s.
- Fall Chinook returning to Battle Creek are predominantly of Coleman NFH origin.
- Numbers of late-fall Chinook salmon returning to Coleman NFH have been relatively stable since 1997 and are almost all of Coleman NFH origin.
- Numbers of steelhead returning to Coleman NFH have been relatively stable since 1990. Numbers of naturally-produced steelhead returning to Battle Creek appear to be increasing.
- Very low numbers of winter Chinook are returning to Battle Creek since the winter Chinook program was moved to Livingston Stone NFH.
- Generally, there is low incidence of straying from Coleman NFH produced salmonids to other tributaries of the upper Sacramento River. Off-site releases result in higher stray rates than releases into Battle Creek.

Questions from the panel:

- Q. Do you have an estimate of the rate of regeneration of clipped adipose fins?
- R. It doesn't appear to be a problem.
- Q. What is the cost of marking in relation to the cost of overall hatchery operations?
- R. No direct answer, but it looks like marking 25% of production would cost about one million dollars.



- Q. Is anything being done with collected otoliths?
- R. Not at this time.
- Q. How was the decision not to mark fall Chinook reached?
- R. Through the budget limitations.
- Q. Could you reduce production and use the extra funds for marking?
- R. Reducing the numbers of fish raised does not save that much money.
- Q. There have been interim (increased) flows in Battle Creek since 1995. Where have fish gone in Battle Creek above the barrier dam?
- R. These flows may not have helped much in the South Fork but may have benefited fish in the North Fork.

### **Diseases in the Central Valley, Battle Creek Basin and Coleman National Fish Hatchery** *Scott Foott, U.S. Fish and Wildlife Service*

Foott had been asked to describe the diseases of Central Valley salmonids, disease problems at Coleman NFH (including control measures) and help define, for the science panel, the risk the hatchery poses to fish in a restored Battle Creek. Foott emphasized that disease is not equal to infection – all fish (hatchery or natural) have multiple infections at any given time. Symptomatic disease is usually a result of an imbalance in the host-pathogen relationship. Pathogens may be opportunistic or obligate, endemic or exotic. In concept there are similar pathogens in both hatchery and natural populations; that is, the pathogens share same water supply and parentage. High density rearing in hatcheries can result in rapid amplification of infection.

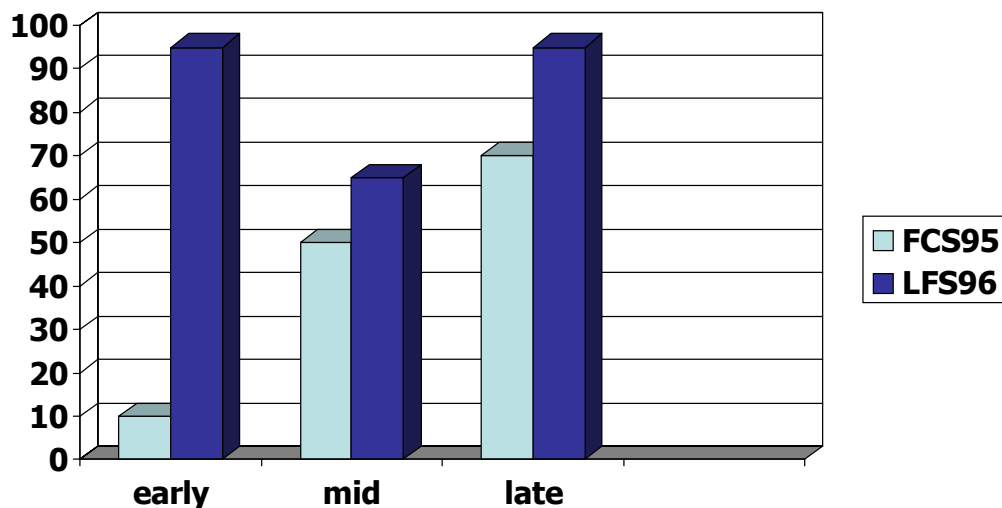
The pathogen list for the Coleman NFH, see Table 2, is quite lengthy but all the pathogens are found in other Central Valley salmonid populations.

**Table 2. Pathogens detected and not detected at Coleman NFH**

<b>Virus detected:</b>	IHNV
<b>Bacteria detected:</b>	<i>F. columnaris</i> , <i>Aeromonas</i> / <i>Psuedomonas</i> <i>R. salmoninarum</i> – adult captive winter run Chinook Yruckeri <i>Asalmonicida</i> (adult)
<b>External parasites detected:</b>	<i>Ichthyoboda</i> ( <i>Costia</i> ), <i>Ichthyophthirius multifiliis</i> (ICH) <i>Trichodina</i> <i>Gyrodactylus</i>
<b>Internal parasites detected:</b>	<i>C. shasta</i> (adult), <i>Speaerothecum destruens</i> (adult) <i>N. salmincola</i> , <i>Hexamita</i>
<b>Central Valley pathogens NOT detected:</b>	<i>M. cerebralis</i> – exotic to CA until 1960s <i>T. byosalmonae</i> (PKD), <i>Enterocytozoon salmonis</i> <i>F. psychrophilum</i> (cold water disease)

Disease prevention at the Coleman NFH and Livingston Stone NFH includes such routine measures as Iodophor treatment (to disinfect eggs), adult surveillance and juvenile diagnostics, segregation, standard sanitation to reduce transmission, and limited drug and chemical treatments. Since the ozone treatment system was installed in 1999 there have been no outbreaks of IHNV in hatchery juveniles. The effect of

ozone treatment is important since there had been seven outbreaks of IHNV in Coleman NFH in the 1990s. IHNV is common in the watershed and returning adults are usually infected with IHNV. For example, the 1999 broodyear fall Chinook (ozone protected at the hatcheries juveniles) returned with a 90% infection rate. Early fish are generally show lower infection rates than later arriving fish (Figure 19), perhaps as a result of increased horizontal transmission among congregations of fish. Steelhead seem less likely to become infected with IHNV than Chinook salmon, even when they are held in situations where the virus is known to be present. Finally there is evidence that IHNV infected fish can survive once they are released. (Clinically diseased fish usually die.)



**Figure 19. Effects of congregation on incidence of IHNV. Overlap of fall Chinook salmon and late fall Chinook salmon at Battle Creek. Source: Scott Foott.**

To test transmission of IHNV from clinically diseased fish to “natural” fish, Foott collected juvenile test fish at the Red Bluff Diversion Dam screw trap and exposed them to 1:1, 1:10, 1:20 rates with the clinically-ill, hatchery fish. The fish were held in circular tanks for 5 minutes and 24 hours. The experimental fish were then held for 7 days post exposure and examined for IHNV. As shown in Table 3, there was no viral detection in any natural fish. In other studies looking at transmission of IHNV from adults to juveniles (on Battle Creek, the upper Sacramento River and the Feather and Yuba rivers), no evidence of transmission to the juveniles has been found.

**Table 3. No viral detection in any natural fish<sup>a</sup>. Source: Scott Foott.**

	1:1	1:10	1:20
5 minutes	0 / 22	0 / 20	0 / 19
24 hours	0 / 12	0 / 13	0 / 12
Control (N)	0 / 1	0 / 8	0 / 17
Hatchery	8 / 8	80 / 80	98 / 98

a. 2-fish pool samples.

In summary, Foott concluded:

- Disease risk of Coleman NFH operations on Battle Creek salmonids appears low.

- It is important to simulate natural exposure conditions for proper risk assessment.

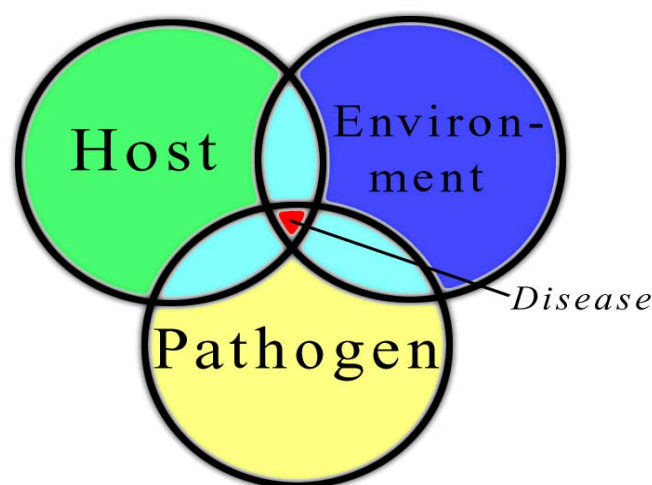
Questions from the panel:

- Q. Have you detected IHNV in water in the hatchery's fish holding area?
- R. No.
- Q. Do you think the virus is being maintained by adults?
- R. We don't see it in any other life stage.
- Q. If you have IHNV free fish, can you tag without concern for infection and fish losses?
- R. Even with infected groups of smolts we still get good adult returns.
- Q. Has IHNV been detected in the Coleman effluent?
- R. IHNV has not been detected.
- Q. In some years there will be big runs of spring Chinook and other fish into Battle Creek and temperature conditions may not be optimum. Do you think there will be severe disease problems?
- R. We have had lots of fish in Battle Creek the last several years and have not seen any disease outbreaks. The water has been cool however.

### **Disease Transmission and Preventative Measures**

*Bill Cox, Dept. of Fish and Game*

Cox began by defining disease as a manifestation of cellular injury resulting in dysfunction of tissues or organs. As diagrammed in Figure 20 infection can result in disease when there is the proper combination of host, pathogen, and environmental conditions. As Warren (1991) said, "Disease can occur when susceptible fish encounter virulent pathogens and adverse environmental conditions stress the fish." Diseases can be transmitted vertically (through sexual products) and horizontally (through direct contact, vectors [birds, mammals, invertebrates], surface waters, and ground waters).



**Figure 20. Disease vs. infection. Source: Bill Cox.**

With regard to the topic of this workshop, there are two pathways of disease transmission of particular concern: from wild fish to hatchery fish and from hatchery fish to wild fish. In the first case in the past 30 years DFG has documented the transmission of various diseases from wild to hatchery fish in the 18 DFG hatcheries with surface water supplies. Disease problems at the four DFG hatcheries on well water have been comparatively minor, thus supporting the conclusion that many disease problems are entering the hatchery via surface water supplies. In the case of Coleman NFH, this disease source has been eliminated or much reduced by installing the ozone system on the intake water line.

Transfer of disease from hatcheries to wild fish is more poorly documented, in part because there are no requirements to monitor this transmission route, and wild fish are more difficult to observe and predators remove sick fish. DFG policy and operations are directed at reducing the risk of diseases being transferred from hatchery to wild population by:

- Not planting obviously diseased fish.
- Not transferring diseased fish from basin to basin.
- Using early detection and treatment to limit disease in hatcheries

There are no California Regional Water Quality Control Board requirements on the discharge of pathogens in hatchery effluents.

Cox discussed the potential problem of disease transmission from adult salmon in the restored watershed to fish being grown and held in the private Mt. Lassen Trout Farm. ***(Authors' note: Although resolution of this issue is being conducted in a separate forum, the topic was briefly introduced in this session.)*** Mt. Lassen Trout Farm has 10 facilities in the watershed, two of which receive water directly from Battle Creek. Others may receive water indirectly through groundwater flow. Studies at DFG's Round Butte (Oregon), Midway (Utah), and Mad River (DFG) hatcheries have shown that pathogens can move up to one-half mile in groundwater. Thus there is the potential for pathogens from wild fish to enter trout hatcheries via groundwater. Options being considered to reduce the risk to the trout farms include buyout, treatment, and changing water supplies.

Minimizing risks to Mt. Lassen Trout Farm, as well as wild fish in Battle Creek and other basins comes in part from DFG's regulatory authority. This authority to regulate fish diseases is derived from the Fish and Game Code and the California Code of Regulations (Title 14 Natural Resources sections). Title 14 describes several categories of diseases ranging from significant to catastrophic. The regulatory process entails the following steps:

- Notify DFG Director
- Notify Aquaculture Disease Committee
- Incur Immediate 30-day holding action
- Take possible further actions, including:
  - Quarantine
  - Crop destruction
  - Facility disinfection
  - Compliance agreement

Questions from the panel:

- Q. Are there any pathogens that might affect the ability to restore Battle Creek?
- R. I don't see any that would be catastrophic. This assumes an overall healthy Battle Creek system.

## **Coleman National Fish Hatchery Barrier Weir and Associated Fish Ladders**

*Scott Hamelberg, U.S. Fish and Wildlife Service*

The Coleman NFH barrier weir and fish ladders (Figure 21) are integral components of hatchery operations. These facilities are designed and operated to:

### **Barrier weir**

- Congregate adult salmon and steelhead for hatchery operations.
- Restrict access of fall Chinook salmon to the upper watershed to protect natural-origin spring Chinook salmon.

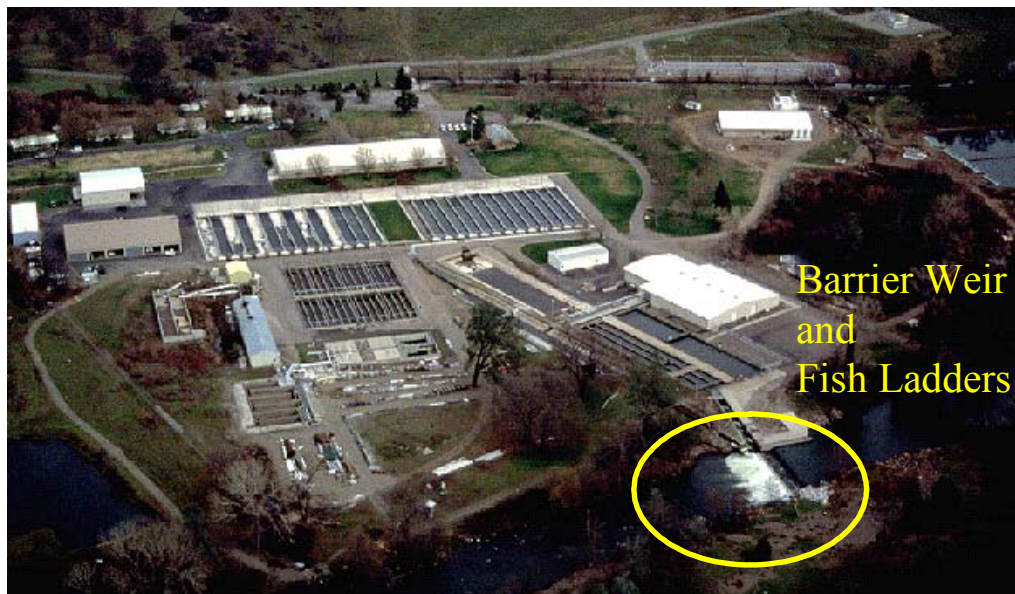
### **Upstream ladder**

- Provide managed passage into upper Battle Creek.
- Provide facilities for monitoring (trapping or video) salmonid populations and other species.

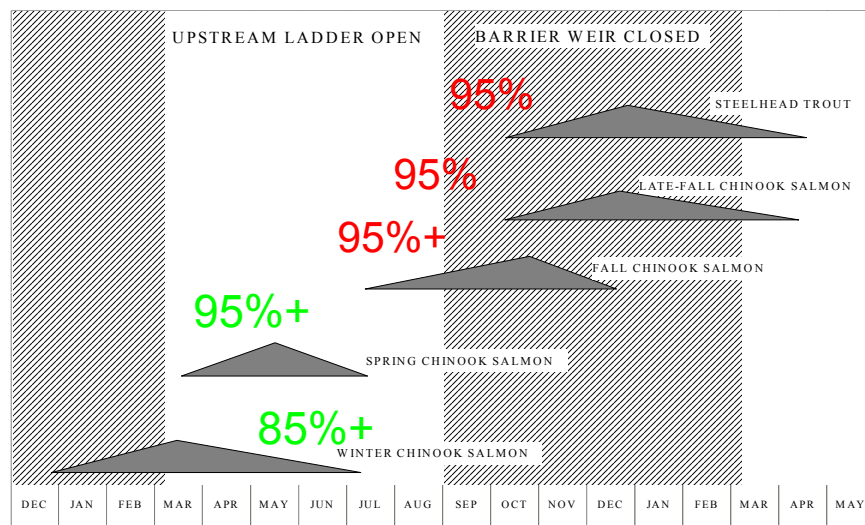
### **Hatchery ladder**

- Provide access from Battle Creek to Coleman NFH broodstock holding ponds.

Adult salmon have been collected in Battle Creek for fish culture since 1895. Temporary seasonal structures were first used in 1943. In 1950, the Department of the Interior constructed the first permanent weir and fish ladders and this structure underwent extensive modifications in 1992. Figure 22 illustrates the present ladder operations schedule and estimates of the percentage of the total run of each race and species that may be passing the structure into the upper watershed. Note that the upstream ladder is generally open from March 1 through August each year and, during this period, provides almost unrestricted access to the upper basin for adult winter and spring Chinook. The ladder is closed during most of the period when adult steelhead are moving onto the upper spawning grounds, thus passing steelhead is an active process; that is, fish are selected from those entering the hatchery and placed above the barrier. As will be shown in the next section, flows affect the barrier's effectiveness in restricting upstream fish movement, therefore the information in Figure 22 does not correctly represent fish passage during the full range of flows that might be expected in Battle Creek.



**Figure 21. Coleman NFH barrier weir and fish ladders: integral components of station operations.**  
**Source: Scott Hamelberg.**



**Figure 22. Barrier weir and ladder operation: relationship to estimates of migration timing. Source: Scott Hamelberg.**

There are discussions underway to modify the structure and operations of the barrier weir and fish ladders. The structural changes are being evaluated by an agency and stakeholder group. Operational changes may come out of these discussions and from the NOAA Fisheries Biological Opinion expected in the near future.

Hamelberg summarized his presentation with the following points:

- Temporary barrier weir structures have been in place in Battle Creek since 1943.
- Permanent structure has been in place since 1950 and rebuilt in 1992.
- Existing structure has multiple features and multiple fish management functions.
- Decisions on current and future facilities and operations are made through open multi-agency process.
- There are a set of proposed structural changes being considered in light of the Battle Creek Restoration project.

Questions from the panel:

- Q. Did the fish barrier cause the observed decline in spring Chinook in Battle Creek.
- R. There has been a general decline in spring Chinook in the Valley and lots of things may have caused the decline...
  - a. Lower flows in Battle Creek as part of 1978 FERC license conditions
  - b. Red Bluff Diversion Dam on the mainstem
  - c. Pumping from the Delta has increased

In spite of these problems, there continues to be evidence of springs in upper Battle Creek.

- Q. What sort of predation impact on spring emigrants might be expected from steelhead and resident fish?

- R. Although we don't have much data, we don't believe this to be a major concern. We have found steelhead to be opportunistic feeders and during the fall and into the winter, gorge on the abundant eggs from fall and late-fall Chinook. Since juvenile Chinook are sight feeders, increased turbidity during flow events would reduce opportunity for predation – especially important if the outmigrants are taking advantage of flow conditions to emigrate.

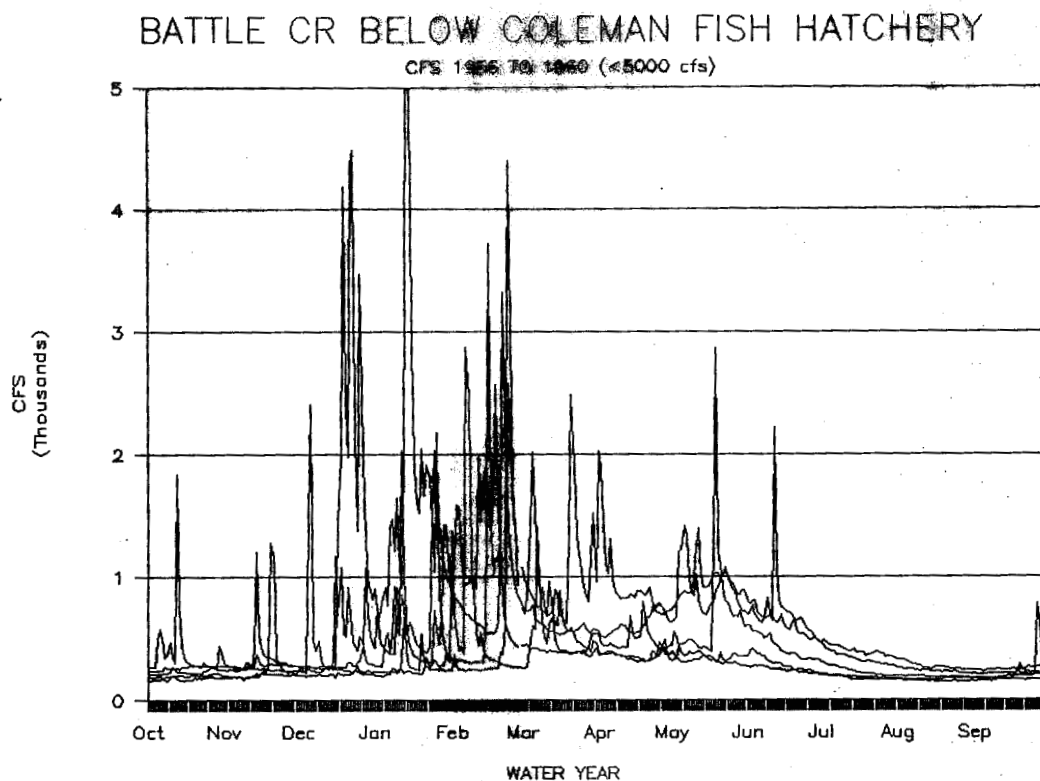
### **Historic Passage of Adult Salmonids Over the Barrier Dam as Affected by Flow**

*Harry Rectenwald, Dept. of Fish and Game*

Rectenwald indicated that, from a stream restoration standpoint, one of the primary purposes of the fish barrier is to restrict the numbers of fall Chinook entering the upper watershed and to prevent over saturating the available habitat. Instead of being a fish tight barrier, however, the barrier's effectiveness in excluding fish varies with flow according the following rough guidelines:

- At or below 250 cfs the weir operates as a total barrier.
- At around 300 cfs some adult salmon or steelhead are able to pass over the barrier.
- At 1,000 cfs many fish are able to pass the barrier.
- At 2,000 cfs there is no barrier to upstream movement.

Hydrographs (see example, Figure 23) demonstrate that flows often occur that allow limited to considerable passage over the barrier. The bottom line is that the barrier is not as absolute as one might think.



**Figure 23. Battle Creek hydrograph below Coleman NFH. Source: Harry Rectenwald.**

## **Proposed Changes in the Fish Barrier and Ladder**

*Jim Smith, U.S. Fish and Wildlife Service*

Smith showed a video illustrating how determined fish can pass the barrier at flows in the range of 300 to 500 cfs. Although the existing barrier and fish ladder complex was constructed fairly recently, there are new standards for ladder and barrier design that are being considered. The new design is a work in progress and several alternatives are being considered by the groups Hamelberg mentioned earlier. Some of the goals being considered for the modifications are:

- Improve fish passage management
  - Improve “fish tightness”
  - Improve upstream ladder
- Improve monitoring capability
- Improve fish sorting capability

## **The Greater Battle Creek Working Group and Memorandum of Understanding**

*Peggy McNutt, The Nature Conservancy*

Some stakeholders became frustrated with the Battle Creek restoration process and held a general belief that:

- Restoration was happening in a vacuum with facilities like the Coleman HFH not considered in the restoration plan.
- Individual groups within the watershed were advocating their particular projects without coordination.
- Stakeholders were being marginalized – in part because they lacked technical staff and time.
- There was no overall watershed strategy.

To help bring order to the process, representatives of seven non-governmental organizations and seven agencies have been working on a Memorandum of Understanding (MOU) to bring shared management to the Battle Creek system. The MOU has been in near-final form for about one year and the group is working to obtain final sign-off from the federal agencies and then obtain signatures from the responsible policy level officials. The MOU incorporates the principals of adaptive management and provides for the coordination of individual projects. One of the shortcomings of the MOU is that there is no provision for funding and staff support.

McNutt remarked that given the diversity of opinion within the group, it is a testament to the importance of the Battle Creek project that the group remains intact and is working together to improve conditions in the watershed.

Questions from the panel:

- Q. With regard to the Compatibility Report, do all members of the BC Work Group have the same issues?
- R. No.
- Q. Are there issues of concern to the BCWG that are not covered in the Compatibility Report?
- R. Yes.



## Genetics of Central Valley Steelhead

Jennifer Nielsen, U.S. Geological Survey

Nielsen recently completed a CALFED funded study of the genetics of Central Valley steelhead (Nielsen et al. 2003). At the time of the workshop a draft of the final report was being reviewed by DFG (CALFED funded the money through DFG), thus the information presented at the workshop should be viewed as preliminary until the report becomes final.

Nielsen used genetic variation found at eleven microsatellite loci to describe the population structure for 23 populations of steelhead trout in the Central Valley, and for sub-populations of steelhead in Clear Creek. (Figure 24 nicely illustrates how the Central Valley now looks to an anadromous fish; that is, foothill dams block access to the watershed of essentially all major streams.) DNA was extracted, amplified and analyzed for 1,570 samples collected by DFG and USFWS staff. As shown in Table 4 samples were collected in the upper Sacramento River, Battle Creek and from Coleman NFH fish, as well as from most other major systems in the Sacramento and San Joaquin valleys. Sampling and analytical details can be found in Nielsen et al. (2003).

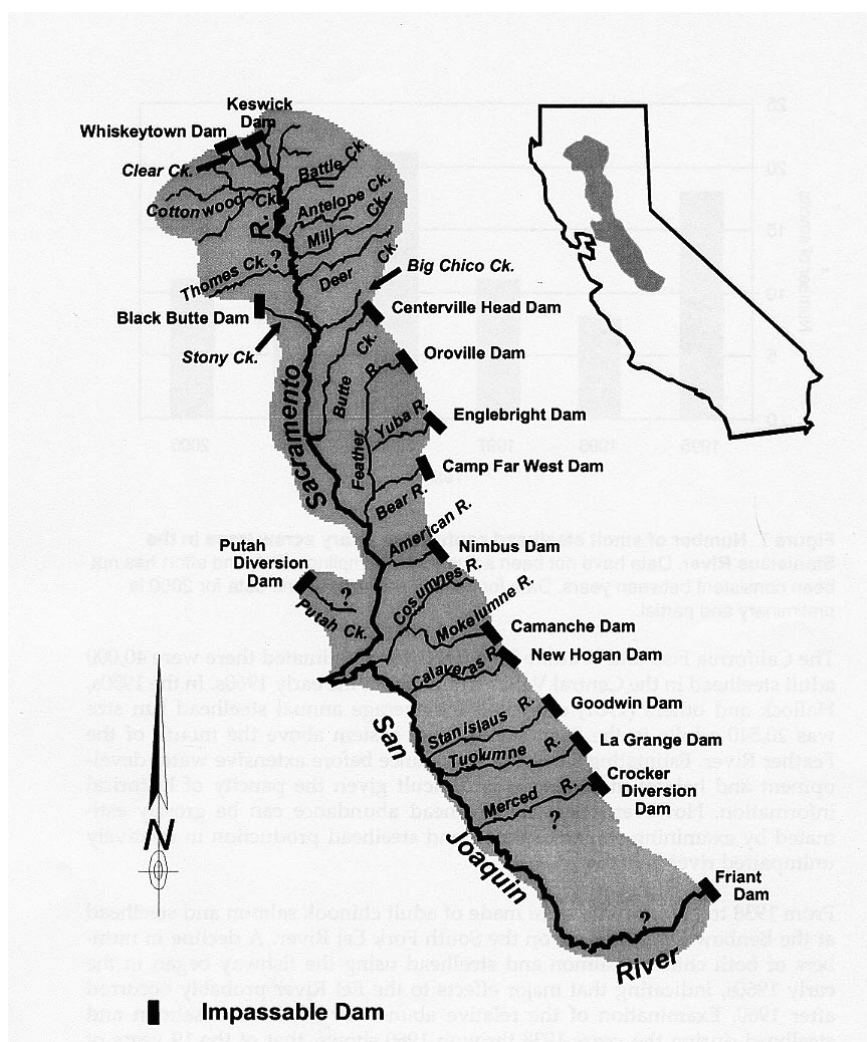
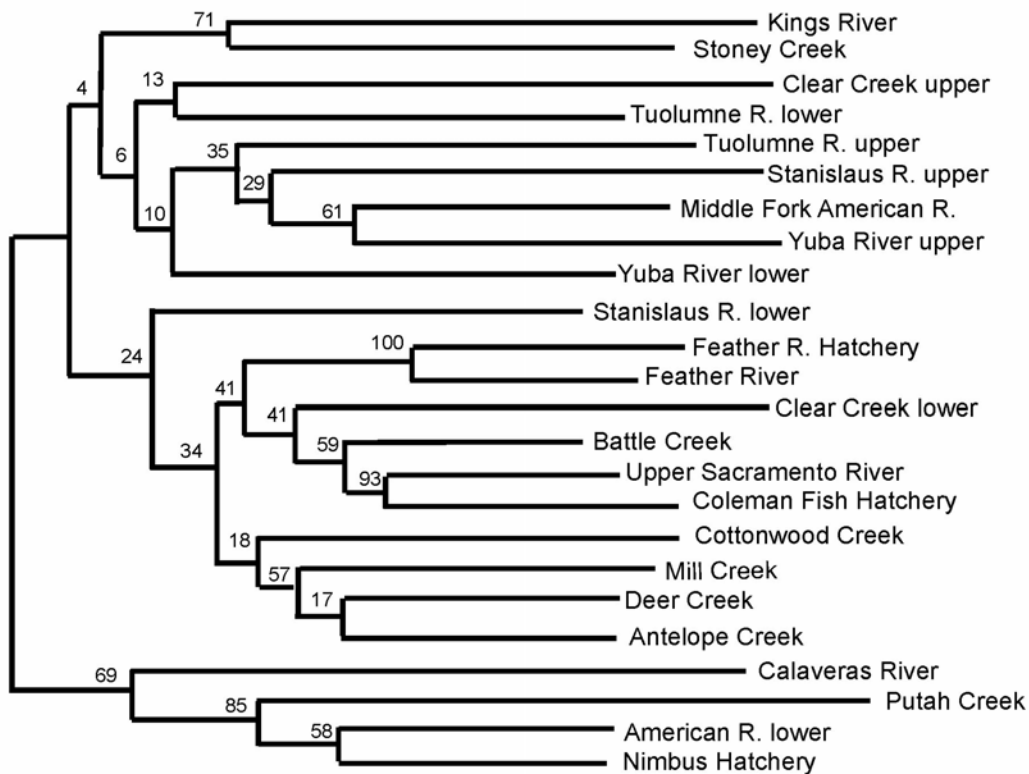


Figure 24. Major streams and impassable barriers of the Central Valley. (From McEwan et al. 2001).

**Table 4 Locations of genetic samples collected for steelhead genetics study. (From Nielsen et al.2003)**

<i>Drainage and Sample Location</i>	<i>N</i>	<i>Year</i>	<i>Collector</i>
<b>Sacramento River</b>			
American River – Middle Fork	44	2002	DFG
American River – lower	41	2002	DFG
Antelope Creek	57	2001-02	DFG
Battle Creek	41	2003	DFG
Clear Creek			
Upper above Bear Creek	43	1999	USFWS
Upper below Bear Creek	64	1999	USFWS
Middle below Whiskeytown Dam	31	1999	USFWS
Lower below Sealtzer Dam	41	1999	USFWS
Lower below Sealtzer Dam	48	2001	USFWS
Cottonwood Creek	34	2001-02	DFG
Deer Creek	46	1999	USFWS
Deer Creek	34	2001	DFG
Feather River	54	2001-02	DFG
Mill Creek	36	1999	USFWS
Mill Creek	39	2001	DFG
Putah Creek	62	2002	DFG
Sacramento River - upper	32	2001	USFWS
Sacramento River - upper	50	2001-02	DFG
Spring Creek	53	1999	USFWS
Stoney Creek	63	2001-02	DFG
Yuba River - upper	58	2001-02	DFG
Yuba River - lower	40	2002	DFG
<b>San Joaquin River</b>			
Calaveras River	60	2002	DFG
Kings River	33	2002	DFG
Lower Stanislaus	45	2001-02	DFG
Upper Stanislaus	49	2002	DFG
Lower Tuolumne	45	2000-01	DFG
Upper Tuolumne	47	2002	DFG
<b>Hatchery</b>			
American Trout & Salmon Co.	47	1999	USFWS
Coleman National Fish Hatchery	92	2001	USFWS
Crystal Hatchery strain	25	1996	JLN
Feather River Hatchery	30	2001-02	DFG
Mount Shasta Hatchery strain	39	1996	JLN
Nimbus Hatchery	47	2002	DFG
<b>Total</b>	1,570		

For purposes of this summary, the information shown in Figure 25, a neighbor-joining tree based on genetic distance conveys the overall picture of the genetic structure of Central Valley steelhead. Basically populations on the same limbs and branches are most closely related.



**Figure 25. Neighbor-joining tree of Central Valley Chinook salmon genetic population structure.**  
**Source: Nielsen et al. 2003.**

A few observations of importance to Battle Creek can be made from the steelhead genetic data.

- Significant population structure remains in Central Valley steelhead, although there is no clear division between Sacramento Valley and San Joaquin Valley populations.
- Hatcheries have apparently affected the genetic structure of steelhead using streams on which the hatcheries are located. For example, naturally spawning (unmarked) steelhead in Battle Creek have no clear genetic separation from Coleman NFH steelhead or steelhead in the upper Sacramento River. Similar results were found on the Feather River (compared with Feather River Hatchery stocks) and the American River (compared with Nimbus stocks).
- Although hatchery and wild fish interaction can be detected at a local scale, the genetic data are not yet adequate to show the influence of hatcheries at a Central Valley-wide scale.
- There were only three steelhead populations in the Central Valley that did not show genetic evidence of recent severe declines – Coleman NFH, Deer Creek, and upper Sacramento River populations.

Nielsen left the group with two questions that need to be addressed in future studies, including Battle Creek and the steelhead supplementation program:

1. Do hatchery fish and naturally spawning trout co-occur and inter-spawn in the watershed?
2. Is there evidence for risks to local populations from hatchery supplementation?

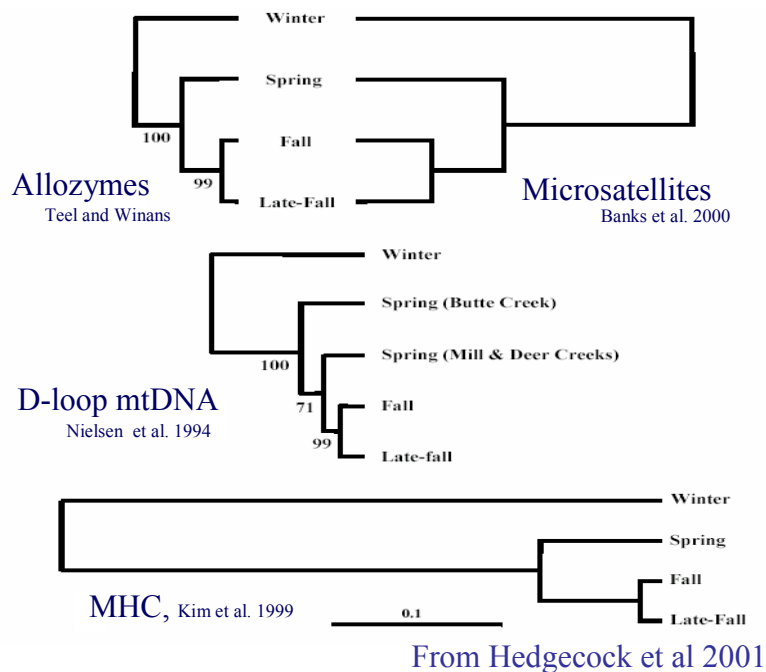
Questions from the panel:

- Q. Is there evidence for risk to natural steelhead populations by hatcheries?
- R. Hatcheries are presently having an impact on local populations but we don't have the data to determine the long term (historic) impacts. We need to take a better look at the total system – not just snapshots.

## Genetics and Life-history Discrimination Among California's Central Valley Chinook Stocks

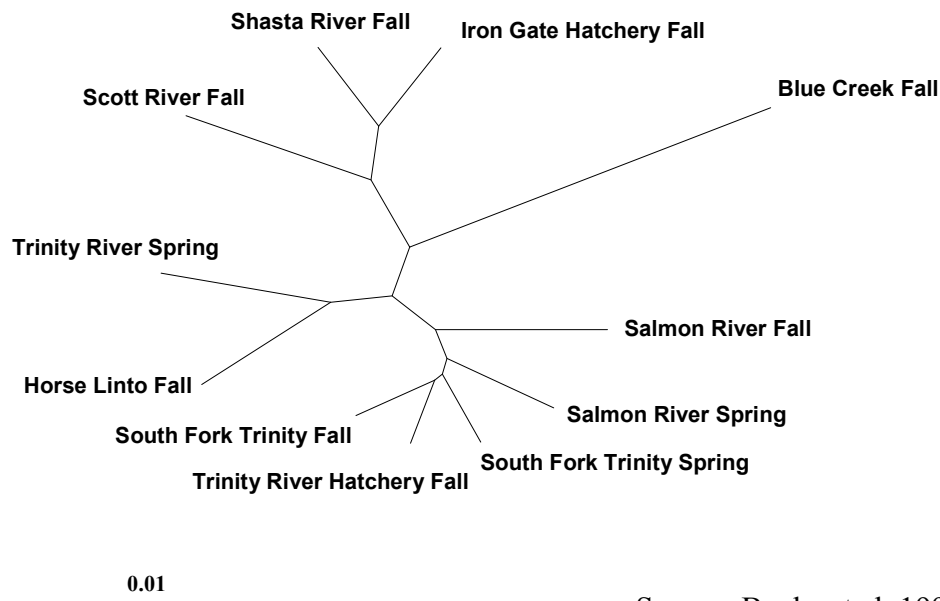
*Michael Banks, Oregon State University*

Banks first summarized some of the general genetic structure of Central Valley Chinook salmon populations, as determined by several genetic techniques (Figure 26). The information to date shows the same general picture – winter run forming a distinct limb, with spring run separated somewhat from and late and late fall. Spring Chinook fall into two genetically similar groups – Mill and Deer creeks and Butte Creek. Fall and late fall Chinook are closely related. Overall, there is relatively little genetic diversity within Central Valley Chinook salmon populations. Banks cited a recent paper on Central Valley fall Chinook (Williamson and May 2003) which used to microsatellites to conclude that these populations were genetically similar from the upper Sacramento River to the lower San Joaquin system.



**Figure 26. Genetic techniques for distinguishing races of Chinook salmon. Source: Michael Banks.**

In contrast to the Central Valley Banks showed information from the Klamath-Trinity system (Figure 27) showing a complex genetic structure among the Chinook populations. It isn't clear why the systems are so different but Central Valley hatchery management practices (off-station releases, inter-drainage transfers of adults and eggs, etc.) are probably a major part of the answer.



Source: Banks et al. 1999

Figure 27. Genetic structure among Chinook salmon populations from the Klamath-Trinity system.

As shown in Figure 28, genetic markers vary in their power to distinguish among individual salmon races. In this case there was a total of 24 markers that could be used distinguish winter Chinook from the other three races. By using the most effective markers (1-10, Figure 28 plate 1) winter Chinook could be completely separated from the other races. The less diagnostic markers did not achieve such separation. Practically this means that individual winter Chinook can be identified with almost complete certainty by use of relatively few markers. Fewer markers mean less costly and faster analyses.

At this time, genetically identifying individual spring Chinook is more difficult and the identification is not as certain. Complete separation could be achieved using 33 markers but this many markers would be too expensive and cumbersome for routine testing. Fewer markers could achieve a fair degree of separation, but there would be increased chance of misidentifying the samples.

Banks cautioned that these results are not final. There are important sampling considerations to consider – adequate N, sampling all life history types, representing temporal variation, for example – in viewing the data. This is still a work in progress.

Banks ended his presentation with a brief discussion of some work his lab is doing on a gene that has a specific function in salmonids and other animals – the clock gene. The hypothesis is that the clock gene is different in runs and the gene may provide another diagnostic tool for run differentiation.

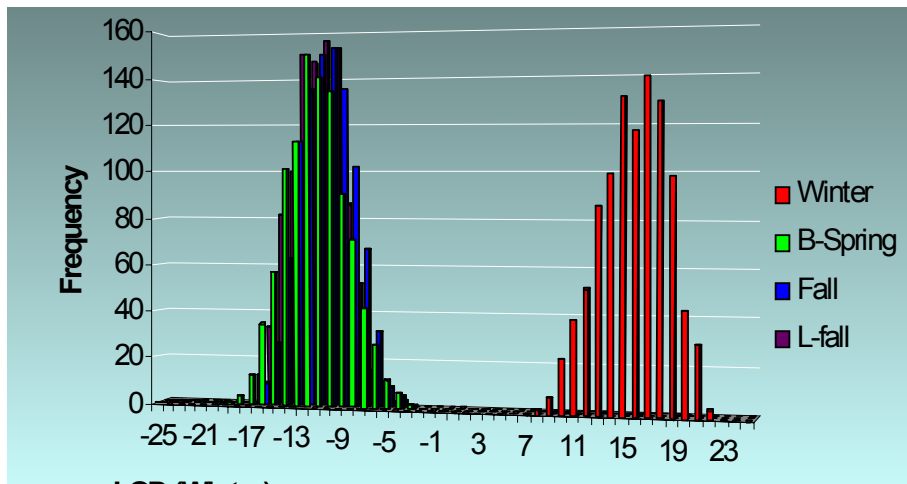


Figure 28, plate 1. Loci ranked 1-10 for winter Chinook salmon discrimination. Source: Michael Banks.

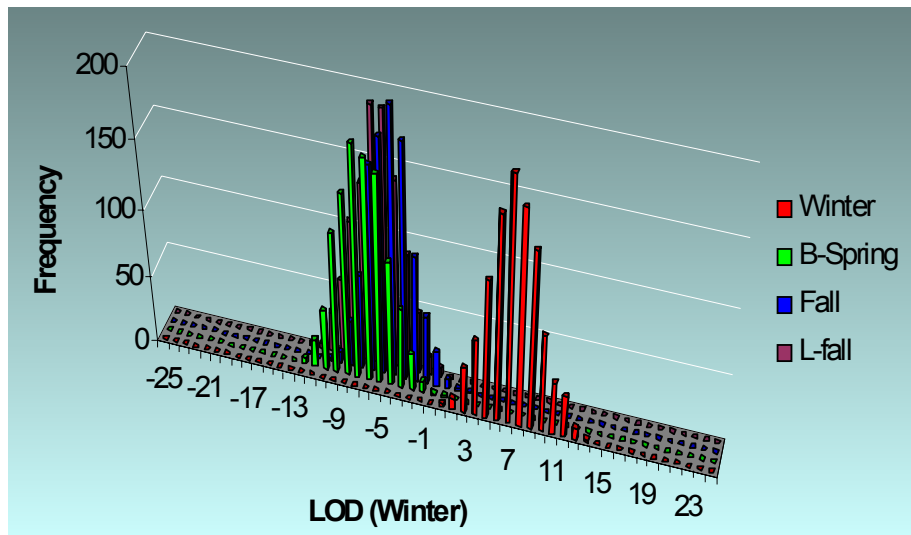


Figure 28, plate 2. Loci ranked 11-20 for winter Chinook discrimination. Source: Michael Banks.

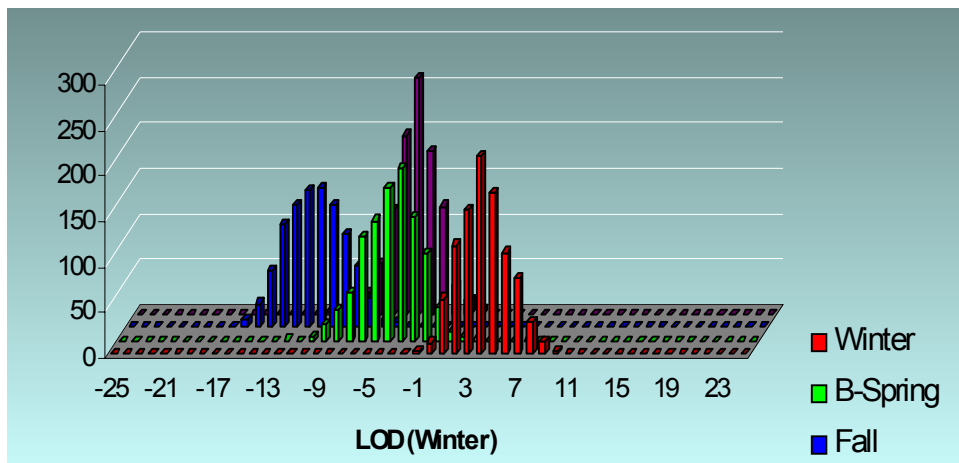


Figure 28, plate 3. Loci ranked 15-24 for winter Chinook discrimination. Source: Michael Banks.

Questions from the panel:

- Q. What does it cost to run genetic analyses on individual fish?
- R. It depends on the number of markers being used. For the winter Chinook, costs are on the order of \$10-20/sample.
- C. The lack of genetic structure in Central Valley Chinook is unique and may be due to the combined effects of hatchery practices.
- C. Another possible explanation is that these salmon are at the southern end of their range and were subject to an extremely variable environment. Increased straying may have been an adaptive feature to survive in this system.

### **Genetic Comparisons Between Hatchery and Natural Origin Steelhead Trapped at the Coleman NFH, 2002–2003**

*Don Campton, U.S. Fish and Wildlife Service*

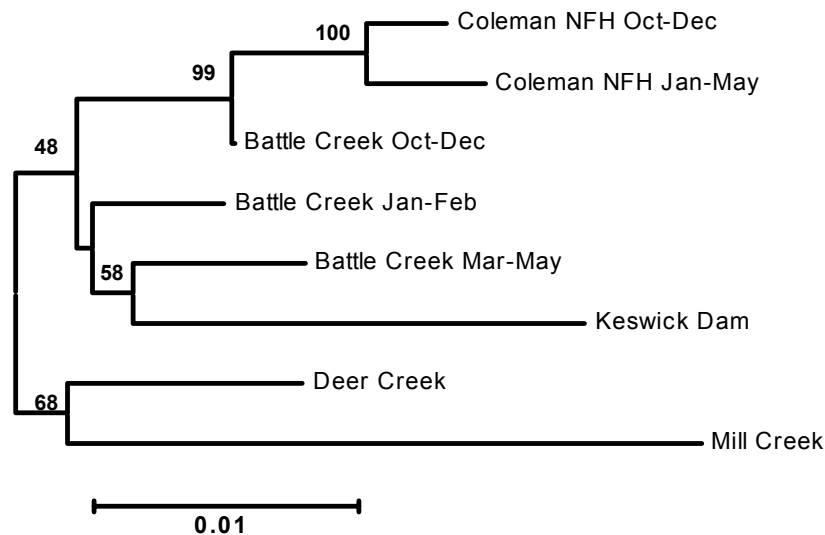
Campton and his colleagues used molecular genetic markers (microsatellites) to examine genetic differences among hatchery (adipose fin clipped) and natural steelhead (no fin clip) collected from the Battle Creek fish barrier dam, the Keswick fish trap, and from Mill and Deer creeks (Table 5).

**Table 5. Examples of allele frequency variation. Source: Campton et al.**

<i>Population</i>	<i>Ocl-1 200</i>	<i>Ogo-4 121</i>	<i>Ots-1 167</i>	<i>Ots-100 174</i>	<i>Ots-100 214</i>
Coleman HOR	0.22	0.11	0.12	0.24	---
Battle Creek NOR	0.18	0.05	0.09	0.13	0.02
Battle Creek (Oct-Dec)	0.21	0.13	0.12	0.17	0.01
Battle Creek (Jan-Feb)	0.16	0.06	0.06	0.12	0.03
Battle Creek (Mar-May)	0.16	0.06	0.04	0.08	0.05
Keswick Dam	0.14	0.07	0.03	0.09	---
Deer Creek	0.08	0.02	0.07	0.09	0.10
Mill Creek	0.04	0.29	0.28	0.06	0.32

The results of these analyses are shown in Figure 29, again in the form of a neighbor-joining tree. Preliminary conclusions from this study are:

- Hatchery and natural-origin steelhead in Battle Creek are more similar genetically than either is to populations in Mill or Deer Creek.
- Hatchery-origin steelhead made a greater genetic contribution to early-returning naturally spawning (non-clipped) steelhead (October to December) than to later returning naturally spawning steelhead.
- Allele frequency differences between hatchery and natural origin steelhead in Battle Creek are relatively small (<0.1) compared to differences between Deer and Mill creeks (>0.2).



**Figure 29. Neighbor-joining tree: CS&E chord distance. Source: Campton et al.**

### **Genetic Monitoring Plan for Hatchery and Natural Origin Steelhead in Battle Creek** *Don Campton, U.S. Fish and Wildlife Service*

Propagation of steelhead at Coleman NFH began in 1947 with the Keswick Dam fish trap providing most of the spawners thus upper river steelhead provided the principal founding stock. In 1995, Coleman NFH began releasing adult hatchery origin (adipose clipped) steelhead above the weir the goal of reestablishing a naturally spawning population. The hatchery broodstock goal is include 20% natural origin fish in the 400 to 800 steelhead used as spawners.

The genetic monitoring plan is part of Battle Creek steelhead supplementation program. The working hypothesis is: Restoration of a naturally spawning population of steelhead in Battle Creek will be faster with hatchery-origin steelhead passed upstream than if no hatchery-origin steelhead are passed upstream. The program goals are to:

- Restore a naturally-spawning population of steelhead in Battle Creek
- Manage the Coleman NFH stock as a genetically-integrated population with natural origin steelhead in Battle Creek
- Minimize genetic divergence between hatchery and natural population components in Battle Creek.
- Assess the genetic and demographic effects of hatchery-origin fish on the naturally spawning population in Battle Creek.

The following steps are integral to the supplementation program:

1. Pass hatchery origin adults upstream to establish natural spawning and natural origin adult recruits in Battle Creek.
2. Increase number of unclipped adults in hatchery broodstock as number of natural origin adult recruits increase. Goal: 10% to 20% unclipped fish in broodstock or 40 to 80 per year.



3. Decrease number of clipped adults passed upstream as number of natural origin recruits increase (sliding scale): number of clipped fish upstream = 2,000 – number of unclipped fish passed upstream.
4. Long-term goal: greater than 2,000 natural adult recruits per year; less than 4% (n = 80) retained for broodstock; and no hatchery origin fish passed upstream.

Campton listed three biological uncertainties associated with the supplementation program:

1. *Ancestry*: Do natural-origin and hatchery-origin fish returning to Battle Creek represent a common gene pool?  $H_0$ : Allele frequencies are equal.
2. *Fitness*: What are the relative phenotypic and genetic fitnesses of hatchery and natural origin steelhead in Battle Creek?  $H_0$ : R/S is equal for hatchery and naturally spawning steelhead in Battle Creek.
3. *Demographic effects*: Do hatchery fish spawning naturally confer a net demographic benefit to the naturally spawning population?

The proposed monitoring program will consist of using microsatellite genetic markers to genetically compare hatchery and natural origin steelhead in Battle Creek. These markers will be used to quantify temporal genetic variation within and between groups to distinguish potential “gene pool” differences (mixed populations) from “stochastic genetic variation” related to breeding structure. The markers will be used to genotype every adult steelhead passed upstream in years 1 through 5 and to genotype all natural origin fish entering the hatchery in years 6 through 10. With these data geneticists can reconstruct the pedigree based on shared DNA markers between potential parents (hatchery or wild) and returning natural-origin adults. Demographic effects will be assessed through the relative reproductive success of WxW, WxH, HxW and HxH crosses. If HxW and WxH have much lower success than WxW, then the release of hatchery fish will be suspended.

Campton summarized his presentation by indicating that the USFWS plans to:

- Continue to develop a genetically-integrated broodstock with a naturally spawning population in Battle Creek.
- Use DNA markers to compare the genetic relationships of hatchery and natural origin steelhead in Battle Creek.
- Use DNA markers to assess the natural reproductive fitness of hatchery and natural origin steelhead.
- Compare the reproductive output of WxW, HxW, WxH, and HxH natural crosses and the demographic contribution of each of those cross types to total returns of natural-origin steelhead in Battle Creek.

Questions from the panel:

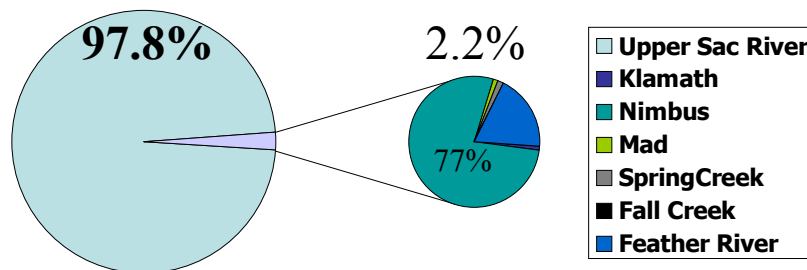
- Q. With respect to the steelhead that trapped at the Keswick fish trap, what was their origin – i.e. there is no spawning above the dam?
- R. This is a work in progress – we are not sure of their origin.
- Q. Is there any evidence of spotty-temporal separation of steelhead passed over the barrier weir.
- R. We don't have that information.
- Q. Are you assuming that adult steelhead trapped at the barrier weir are there to spawn?

- R. They may not be there to spawn and are strays that randomly enter Battle Creek (“dipping in”). We need to determine the origin of these unmarked fish.
- Q. Is the goal to have no gene flow from the hatcheries?
- R. Yes.
- Q. Will the monitoring plan help determine if fish are becoming less domesticated in the supplementation program?
- R. The monitoring plan is a straw proposal. We will be using adaptive management to help sort it all out.
- Q. What happens if you get the 2000 fish, stop putting hatchery fish above the barrier dam and then the population declines?
- R. Not sure. The hatchery staff and Campton would consult on the question.
- Q. Can we reliably establish pedigrees of steelhead in Battle Creek?
- R. Yes, we can get a high degree of accuracy with 10-15 markers.
- Q. Is there a budget for the monitoring?
- R. Yes.

### **Coleman NFH: Founding Stocks, Broodstock Collection, and Spawning Strategies**

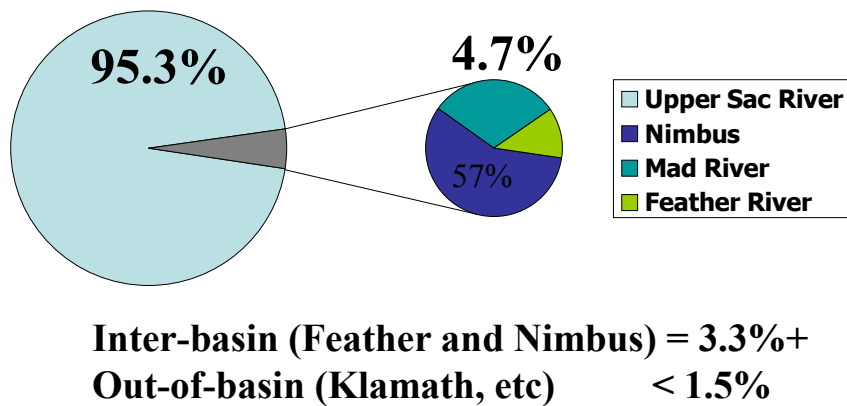
*Scott Hamelberg, U.S. Fish and Wildlife Service*

When the Coleman NFH was opened in 1942, founding broodstock was collected from Battle Creek, a fish trap at Keswick Dam, and at a trap at Balls Ferry (downstream of Battle Creek on the Sacramento River). In 1943 the Department of the Interior constructed a weir on Battle Creek to facilitate broodstock collection. In 1950 the permanent barrier weir and fish ladders on Battle Creek simplified broodstock collection. Currently all broodstock is collected in Battle Creek (fall and late fall Chinook and steelhead) or from the Keswick Dam fish trap (late fall and winter Chinook, with winter Chinook destined for the Livingston Stone NFH). Although most of the genetic material in Coleman NFH stocks originated from Battle Creek and upper river runs, a limited amount of material came from other Central Valley and out of basin hatcheries (see Figures 30 and 31 for Chinook salmon and steelhead, respectively). There is currently no deliberate importation of eggs or adults from other systems, although strays from other hatcheries may spawn with, or be spawned with, local fish.



Inter-basin (Feather and Nimbus) = 2.1%+  
 Out-of-basin (Klamath, etc) < 0.1%

**Figure 30. Origin of juvenile fall Chinook salmon released from Coleman NFH, broodyears 1945–2000. Source: Scott Hamelberg.**



**Figure 31. Origin of juvenile steelhead released from Coleman NFH, broodyears 1948–2000. Source: Scott Hamelberg.**

The current guiding principals for broodstock collection at Coleman NFH are:

- Use upper Sacramento River or Battle Creek adults;
- Represent spectrum of migration/spawning timing;
- Include all age classes;
- Incorporate natural-origin adults;
- Use 1 to 1 mating protocol; and
- Incorporate large numbers of adults.

Examination of spawning protocols for each stock or species includes consideration of broodstock collection timing, broodstock spawning timing, numbers of spawners, incorporation of natural-origin broodstock, and hybridization potential. Some specific broodstock collection procedures and issues by race or species are described further.

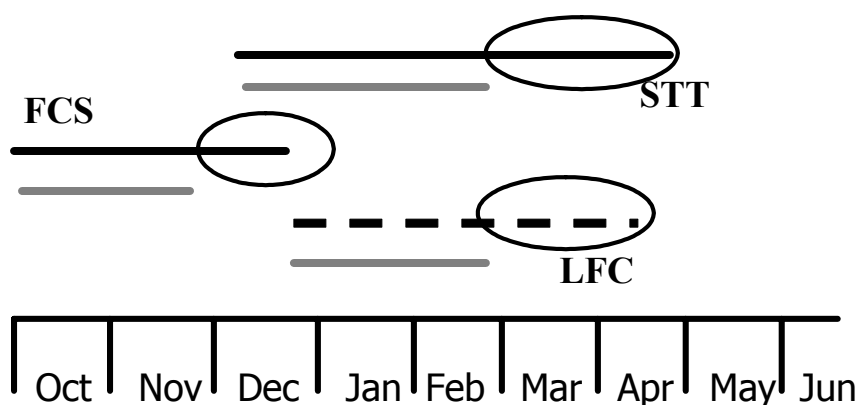
*Fall Chinook.* There is concern about overlap in run timing between fall, spring, and late fall Chinook, which creates the potential for hybridization problems, see Figure 32. Mark rates, migration timing, and phenotypic characterization are used to minimize potential for hybridization. Specific fall run protocols are:

- Incorporate 10,000 adult spawners;
- Incorporate natural-origin adults;
- Use 1 to 1 mating protocol; and
- Incorporate adults from “available” segments of the run and from all age classes (meaning jacks are included in the broodstock).

*Late fall Chinook.* The hybridization concern is with overlap with fall with winter Chinook migration timing. Again tag information and phenotypic characterizations are used to minimize potential for mixing the two races. Specific late fall run protocols are:

- Incorporate 550 to 1,000 adults in spawning matrix. Coleman NFH adults are all marked;
- Incorporate 25% (135) natural-origin adults from Keswick Dam fish trap. Adults from the Keswick trap are fully mature;

- Use 1 to 1 mating protocol; and
- Incorporate adults from “available” segments of the run and from all age classes.



**Figure 32. Expected spawning timing (black lines) vs. hatchery spawning period (grey lines). FCS, fall chinook salmon; STT, steelhead rainbow trout; LFC, late fall Chinook salmon. Source: Scott Hamelberg.**

*Steelhead.* Specific steelhead spawning protocols are:

- Incorporate 800 adults in spawning matrix (760 marked fish);
- Incorporate 10% (40) natural-origin adults from Battle Creek (unmarked fish);
- Use 1 to 1 mating protocol;
- Incorporate adults from “available” segments of the run and from all age classes; and
- Use live spawning.

Hamelberg summarized his presentation with the following points:

- Infrequent transfer of genetic material from other areas has occurred over the course of operations at Coleman NFH at low percent.
- Current operations have no deliberate importation of eggs, juveniles, or broodstock.
- Current broodstock collection windows target large percentage of expected migration timing.
- Current spawning windows are shorter than expected for natural counterparts (steelhead and fall Chinook programs are implementing or discussing changes).
- Large numbers of adults used in all programs at Coleman NFH.
- 1 to 1 matings or better are used for all programs.
- Potential for inadvertent hybridization exists due to run overlap in migration and spawning timing. Protocols are in place to eliminate or reduce potential for hybridization
- All stocks propagated at Coleman NFH and Livingston Stone NFH are considered part of the Central Valley ESU.
- All hatchery programs integrate natural-origin adults into the spawning matrix to reduce potential genetic divergence of hatchery-origin fish.

Questions from the panel:

Q. Is there any genetic or phenotypic differentiation between wild and hatchery late fall?

R. No.

Q. What percent of steelhead and fall Chinook entering the hatchery are of natural origin?

R. Around 20% and 7-20% respectively.

Q. Are you looking at late fall or other scale patterns to determine where these fish are spending their time post release?

R. We have not looked at scales.

Q. Why release steelhead at Balls Ferry? Do you see much evidence of straying due to this release strategy?

R. Fish are released at Balls Ferry to limit predation. We don't see many ad clipped steelhead in the upper river.

Q. Do late fall released from CNFH return to Battle Creek?

R. They mostly come back to the hatchery.

## **The NOAA Fisheries Biological Opinion on Operation of Coleman NFH**

*Shirley Witalis, NOAA Fisheries*

NOAA Fisheries is drafting a biological opinion that will influence operation of Coleman NFH and Livingston Stone NFH. The biological opinion will be based on the 2001 biological assessment of artificial propagation, including incidental take of listed species, plus other information provided NOAA since the USFWS released the biological assessment. A draft version has been reviewed once internally and NOAA intends to send the final version to the USFWS by the end of 2003.

Although Witalis was not able to discuss any specifics in the draft opinion, the following components will likely be included:

- Program description
- The steelhead supplementation program
- Barrier weir and fish ladders
- Genetics
- Broodstock collection
- Intake screens
- Monitoring
- Production goals – juvenile releases and adult returns – and their effects on listed species

There was some discussion of the supplementation and monitoring elements and what they might mean to the hatchery and Battle Creek restoration. Some of the points made are described further.

*Steelhead Supplementation Program.* NOAA Fisheries agreed to bypassing of steelhead into upper Battle Creek in 1995 to extend the range of natural steelhead. This action would not adversely affect the listed winter-run Chinook salmon, and natural steelhead could not be distinguished from hatchery steelhead at that time. This position was reviewed when Central Valley steelhead were listed in 1998; NOAA Fisheries

continued to support the release of all steelhead in excess of broodstock needs at Coleman NFH as preferable to restriction of passage to only a fraction of the run. Hatchery steelhead are now 100 percent marked, and their origin could be distinguished in the 2002 return run, at which time NOAA Fisheries requested that the bypassing of Coleman NFH steelhead be stopped. USFWS did not incorporate any natural steelhead into their broodstock that year; but did request to do so in the coming years, and NOAA Fisheries agreed with this management practice.

USFWS wished to take advantage of excess steelhead numbers by continuing steelhead supplementation into upper Battle Creek. NOAA Fisheries does not have a policy regarding supplementation, but has stated that the practice is experimental should be used conservatively. Many supplementation studies involve out-of-basin fish, with poor results. Because Battle Creek steelhead are genetically related to the Coleman NFH stock, and USFWS and NOAA Fisheries geneticists were in agreement that not bypassing the hatchery steelhead was a greater risk than hybridization between hatchery and natural steelhead, NOAA Fisheries has agreed to research steelhead supplementation in upper Battle Creek.

*Monitoring.* Witalis stressed the importance of the marking of hatchery fish and the current on-going investigations being carried out on marking methodology: the constant fractional marking study, to be completed in 2004; the automated tagging study, which will include an evaluation and final report upon its' completion; and the interest in otolith marking as standard hatchery protocol, with some comments on the Coleman NFH's otolith study. She stated that otolith marking would be considered as a supplemental mark, and that it would still be necessary to have an external mark.

Questions from the panel:

- Q. Other than marking, what else will you be recommending in the biological opinion?
- R. Marking will be one of the data needs included in the opinion. NOAA Fisheries is recommending a consistent marking program for hatchery fish. We also recommend that the relationship between fish production and fish escapement be investigated to determine what control, if any, the hatchery may have on high numbers of fish returns. NOAA Fisheries supports screening the hatchery intakes as a protective measure for out-migrating juveniles, especially as it is expected that a restored upper Battle Creek will increase natural fish production. NOAA Fisheries is supporting a new hatchery weir design which could accommodate future passive monitoring in Battle Creek.
- Q. Do you envision recommending a genetics monitoring program as outlined by Don Campton?
- R. We view this program as experimental and will not be including genetic monitoring in the BO.
- Q. What would be the NOAA criteria to stop the supplementation program?
- R. This has not been defined. We assume the adaptive management elements would allow us to determine if the program was having adverse impacts and needed to be stopped. Genetics has its own section in the biological opinion, and is a component of hatchery management that has implications to natural populations. Genetic monitoring is also a necessary feedback element for the adaptive management of the supplementation program.
- C. Adaptive management is being used pretty loosely in this workshop. You will need a more formal process with conceptual models and feedback loops – even for passive adaptive management.
- C. The winter Chinook propagation program does show a form of adaptive management being used at CNFH. Data were collected and after analysis, the program was stopped for two years and then moved to Livingston Stone.

## **A Conversation About Restoration Alternatives Pertaining to Coleman NFH**

*Mike Ward, representing the Battle Creek Watershed Conservancy*

The Battle Creek Watershed Conservancy supports most aspects of the restoration plan but is not certain what “restoring” Battle Creek means and how will we know if we are successful. Different biological principals about restoration have been stated in various agency reports (see below). In addition, individual agencies and organizations may have different goals - delisting salmon and steelhead, certainty in hydropower operations, and doubling natural runs of anadromous salmon. Ward emphasized that the aim should be high - if the project is a success the fish will be there for a long time.

The following biological principles are considered essential for restoration in Battle Creek according to the agencies USFWS, NOAA Fisheries, DFG, and USBR:

- “Biological Effectiveness: “Restoration actions must... provide the highest certainty... restore ecosystem functions and self-sustaining populations of native fish in a timely manner.
- Restore Natural Processes: “Restoration actions must... mimic the... conditions under which Battle Creek anadromous fish resources evolved...”
- Biological Certainty: “Restoration actions must provide maximum long-term effectiveness by minimizing long-term dependence on the integrity of man-made restoration actions and the cooperation of future project owners and operators.”

The Battle Creek Working Group’s Compatibility Report, supported by most working group members, was intended to point towards the right path. Some of the alternatives suggested in the report were to be assessed by the USFWS. Also included was the need for a better connection of the lower and upper parts of Battle Creek. For whatever reason, the connection and the assessments have not happened. The Conservancy is concerned that the Compatibility Report is no longer being considered when thinking about the Coleman NFH and Battle Creek restoration.

One of the central themes in the Compatibility Report was isolation of the hatchery versus synthesis; that is, with synthesis meaning the hatchery is an integral part of the watershed. Although it may be possible to blend the two approaches, it is not clear what adaptive processes we need to isolate as part of the blend. Ward briefly described two examples of how Coleman NFH can be isolated from Battle Creek – move some of the production and an alternate connection from the hatchery to the Sacramento River.

*Moving Production of Late Fall Chinook and Steelhead to Livingston Stone NFH or Other Site on the Upper Sacramento River.* Ward cited the following advantages and financial related aspects of such a move.

- Minimizes (toward zero) Coleman NFH ecological and genetic impacts on Battle Creek late fall and steelhead
- As shown by moving winter Chinook program to Livingston Stone, it can work.
- Capital costs of moving the winter Chinook program were less than \$1 million
- Annual cost of winter Chinook program are about \$178,000
- The move of steelhead and late fall production could result in an annual ozonation power saved: at Coleman NFH of perhaps \$400K – \$1.6 million (annual ozonation power use about 2.4 MW)

*Alternate Connection to the Sacramento River.* The compability report suggests that the USFWS explore the option of using the Gover ditch to connect the hatchery to the river (Figure 33). Ward emphasized that considerable work needs to be done before the technical and biological feasibility of this alternative can be evaluated but it shouldn’t be discarded before the evaluation is made.



**Figure 33. Possible alternate connection to Sacramento River (showing Gover ditch). Source: Michael Ward.**

The Conservancy concurs that adaptive management must be an integral part of the Battle Creek restoration project and hopes the panel recognizes need for equal or better adaptive management at Coleman NFH. Stakeholders need to be equal partners in policy and technical decisions coming out of the adaptive management program. However, we should not allow planning for adaptive management stand in way of any critical implementation actions or studies.

Ward wound up his presentation for a call for a more comprehensive marking program at the Coleman NFH to help sort out wild from naturally spawning salmonids and cited federal legislation requiring fish released from federal hatcheries to marked. ***(Authors' note: Marking does not necessarily mean tagging and marking only would not allow Coleman fish to be distinguished from other adipose clipped hatchery fish.)*** If all Coleman NFH fall Chinook were marked or clipped, or coded wire tagged, costs estimates (from Northwest Marine Technology) would be on the order of:

- Ad-clip only – 12 million Coleman NFH fall chinook
  - \$3,340,000 capitol cost
  - \$235,536 annual cost
- 100% Ad-clip plus agency only coded wire tag
  - \$3,340,000 capitol cost
  - \$646,181 annual cost

Questions from the panel:

- Q. Do you have historical data showing late fall Chinook were in Battle Creek?
- R. Although there are no hard and fast data, locals say there were fish in the system that had the attributes of late fall run.
- Q. Are flows and temperatures in Gover Ditch adequate for Chinook salmon?
- R. More data and analysis are needed to determine if this alternative will work. Preliminary data indicate that temperatures will be generally ok and flows should be ok, although October could be a problem.



- Q. What do you see the role of steelhead supplementation to be in the Battle Creek restoration program?
- R. This isn't clear since there is no overall recovery plan bringing this all together.
- Q. Can late fall and steelhead production be moved to Livingston Stone?
- R. By Buford Holt, USBR. It could work physically.

## **Evaluation of the Winter Chinook Supplementation Program at the Livingston Stone NFH using the Sacramento River Carcass Survey**

*Kevin Niemela, U.S. Fish and Wildlife Service*

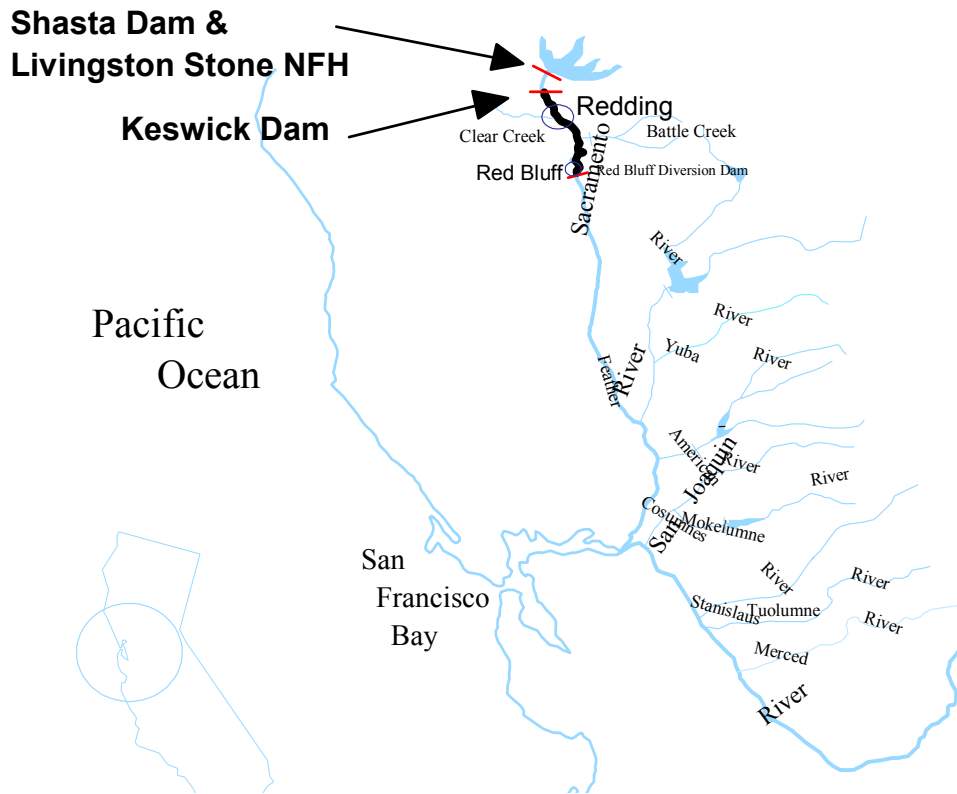
The topic of the winter Chinook propagation program at Livingston Stone NFH was included on the agenda to provide background on an existing supplementation program under the direction of the USFWS. The Livingston Stone NFH began to propagate winter Chinook in 1998, after the program was moved from the Coleman NFH. The program objective is to supplement natural spawning and the goal is to recover and delist the race.

Figure 34 shows the hatchery location (at the base of Shasta Dam) and other features of the upper Sacramento River system. Figure 35 illustrates the trend in estimated winter Chinook spawning stocks and some important events occurring over the past three decades. The winter Chinook propagation program was one of the key elements in a series of actions proposed in the late 1980s to help restore this race.

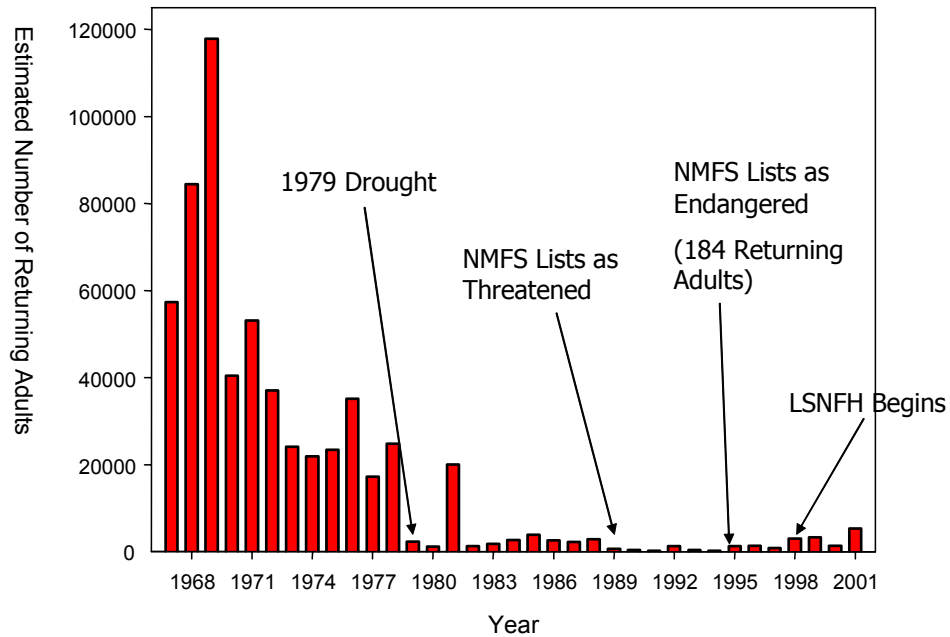
Winter Chinook broodstock is collected by use of a fish trap located at Keswick Dam – a structure used to regulate flows from Shasta Reservoir. Since winter Chinook is listed, spawning procedures are designed to ensure that the hatchery contribution does not adversely affect effective spawning size. The following guidelines govern broodstock selection and spawning.

- Broodstock collected across range of migration timing.
- Broodstock target: 15% of run size but no more than 120 spawners.
- Maximum of 10% of the spawners can be of direct hatchery origin.
- To eliminate the chances of hybridization, broodstock selection is based on genetic screening.

The target numbers of broodstock fish over the temporal migration range by month are shown in Table 6.



**Figure 34. Location of Livingston Stone NFF and other features of the upper Sacramento River system. Source: Kevin Niemela.**



**Figure 35. Population estimates for Sacramento River winter Chinook salmon, 1967-2001. Source: Dept. of Fish and Game.**

**Table 6. Broodstock collection targets over the range of migration timing**

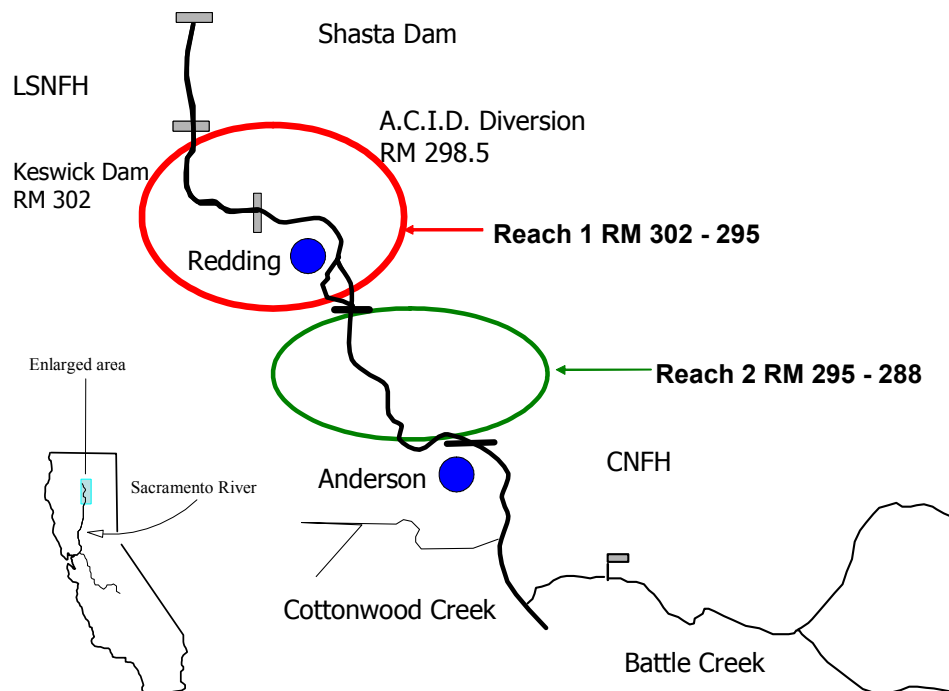
<i>Month</i>	<i>Collection Target</i>
December	2
January	6
February	11
March	43
April	34
May	11
June	8
July	4

In late January-early February, USFWS crews truck the pre-smolts to a site in the upper Sacramento River for release. Dusk releases are made to limit predation and stress.

The USFWS and DFG conduct a winter Chinook carcass survey to:

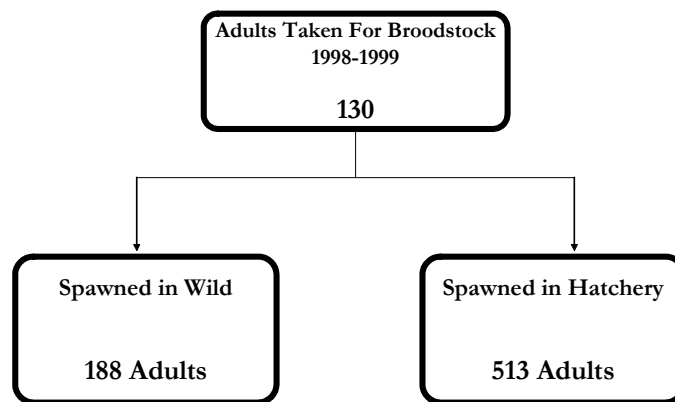
- Estimate spawner abundance;
- Provide information on life history attributes;
- Collect tissues for genetic run assignment; and
- Evaluate the supplementation program at Livingston Stone NFH.

The carcass surveys are conducted from May through August in the principal winter run spawning areas (Figure 36). The field crews use a boat near each shore to collect carcasses sex, measure, tag, collect tissue samples, and collect heads from those with adipose fin clips before returning them to the river.



**Figure 36. Principal winter run Chinook salmon spawning areas. Source: Kevin Niemela.**

USFWS staff first looked at the predicted contribution of Livingston Stone NFH 1998-1999 broodyear fish to the overall return from that cohort (Figure 37). Based on run size estimates for the naturally spawning winter Chinook population, they calculated estimates of cohort replacement rates. Based on the cohort replacement rates, they estimated that, had those 130 adults not been collected for broodstock but, rather, been allowed to spawn naturally, they would have contributed 188 adults to the naturally spawning winter Chinook population during the 2001 return year. However, based on expansion of CWT recoveries, an estimated 513 hatchery-origin winter Chinook were produced from the same 130 adults collected as hatchery broodstock – an increase of 273% above the level of production by those 130 fish, had they been allowed to spawn naturally. Therefore, they determined that the supplementation program actually did increase the numbers of winter Chinook returning to the Sacramento River, and the program was not in actuality “mining” spawning adults from the natural spawning population without producing a demographic benefit.



**Figure 37. Recruitment. Source: Kevin Niemela.**

Comparing data from tagged and untagged winter Chinook carcasses can help determine if hatchery fish differ significantly from wild (naturally spawning) salmon. As shown in Figure 38, plates 1 and 2, and Table 7, spatial and temporal distribution and age and sex are similar, although there is a higher percentage of jacks in the hatchery carcasses. Body size was significantly smaller for tagged versus untagged fish.

Genetic analysis of the tissue samples collected from the carcasses was used to assign the fish to race (Figure 39). As shown in the bar chart the temporal distribution of the tissue samples (and fish) follows a rather normal-looking, bell-shaped curve, skewed somewhat to the left. The line graph indicates that the proportion of carcasses identified genetically as winter Chinook is high throughout the survey period, beginning at about 70%, increasing to near 100% by early June and remaining at about that level for the duration of the survey period. The bell curve also indicates that the survey is probably covering the entire spawning period.

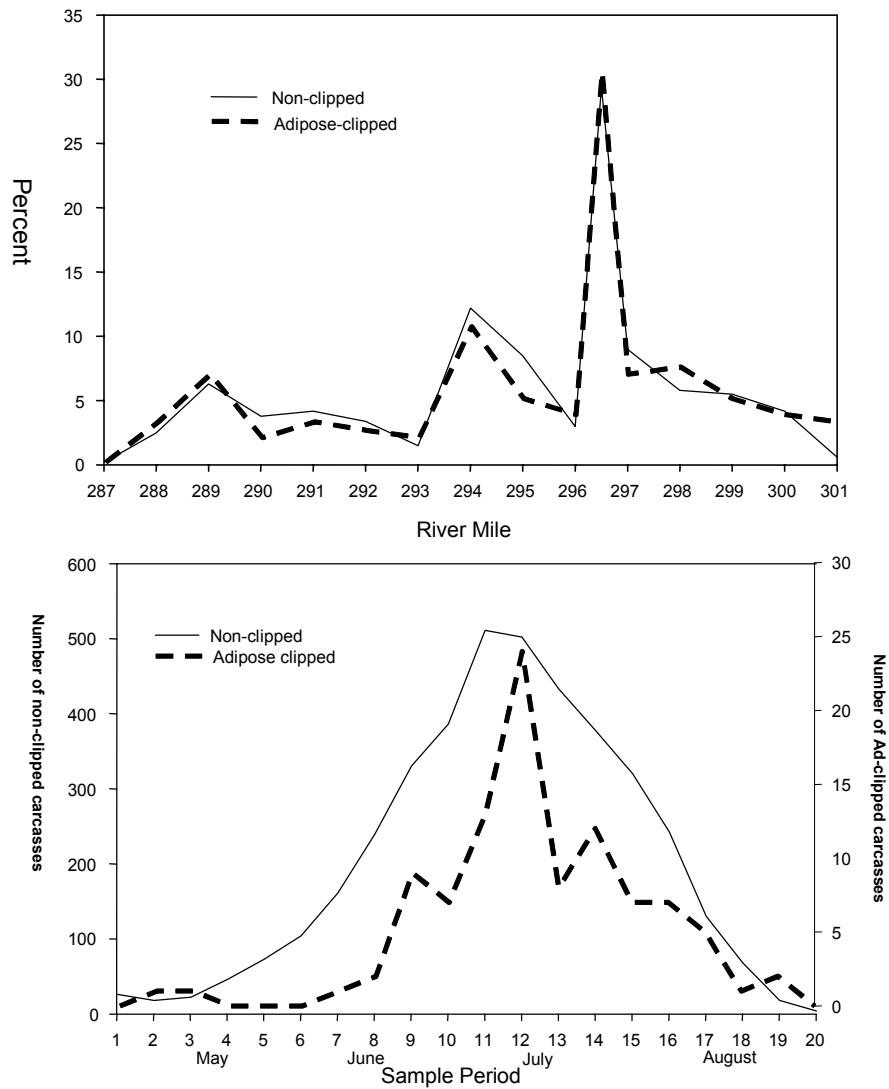
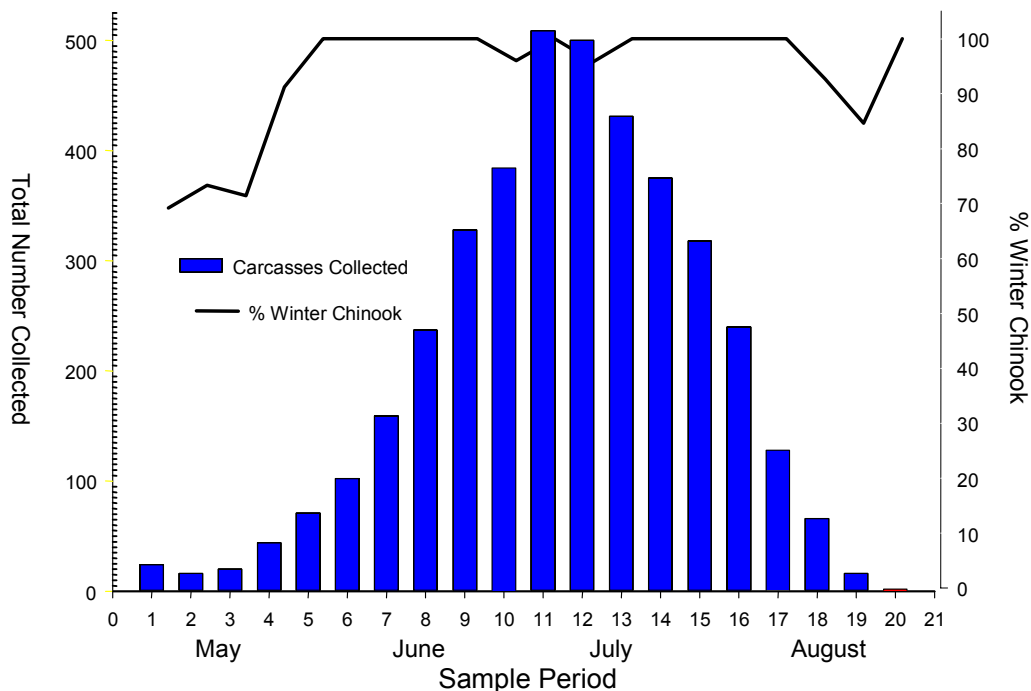


Figure 38, plates 1–2. 1. Spatial distribution. 2. Temporal distribution. Source: Kevin Niemela.

Table 7. Age and sex composition of ad-clipped and non ad-clipped winter Chinook salmon. Source: Dept. of Fish and Game.

Category	Adipose fin clipped	Non-adipose fin clipped
Males	43%	34%
2-year olds	27.4%	10.3%
3-year olds	72.6%	85.5%
4-year olds	---	4.1%



**Figure 39. Tissue sample results. Source: Kevin Niemela.**

Niemela summarized his presentation with the following conclusions:

#### **Recruitment**

- The propagation program has resulted in a moderate increase in adult returns.

#### **Spatial Distribution**

- Within habitats surveyed, spawning distribution was similar between hatchery and natural-origin fish.

#### **Temporal Distribution**

- Spawn timing appears similar for hatchery and natural-origin winter Chinook.

#### **Age and Sex Composition**

- There is an increased incidence of 2-year old males among hatchery-origin winter Chinook.

#### **CWT Recoveries**

- Hatchery contribution includes most family groups, including captive x captive crosses.

#### **Spawning Status**

- No pre-spawning mortality was observed for hatchery-origin winter Chinook.

#### **Body Size**

- Hatchery-origin fish were statistically smaller than their natural-origin counterparts during 2001.

Tissue Samples

- Most of the salmon tissues collected in the carcass survey were genetically identified as winter Chinook.
- The sampling program appears to be covering the entire spawning season.

Question from the panel:

- Q. Is DFG taking scales from winter Chinook carcasses, if so, are they being used to back calculate life history stages?
- R. DFG is taking scales but I am not aware of plans to read them and analyze them.

## **A Brief Look at Battle Creek Monitoring**

*Matt Brown, U.S. Fish and Wildlife Service*

Brown mentioned that monitoring is an essential element of the Battle Creek restoration project Memorandum of Understanding. **(Authors' note: This MOU is for the restoration project only and not the same one McNutt described for the entire watershed.)** The overall objectives of the presentation were to address the following topics:

- The effects of the Battle Creek restoration project, the Coleman NFH, and outside influences on salmonid populations in Battle Creek;
- Escapement estimating procedures;
- Carrying capacity in Battle Creek;
- Emigration timing and estimate natural production;
- Evaluating the impacts of the barrier weir; and
- Determining if hybridization between fall and spring Chinook is occurring.

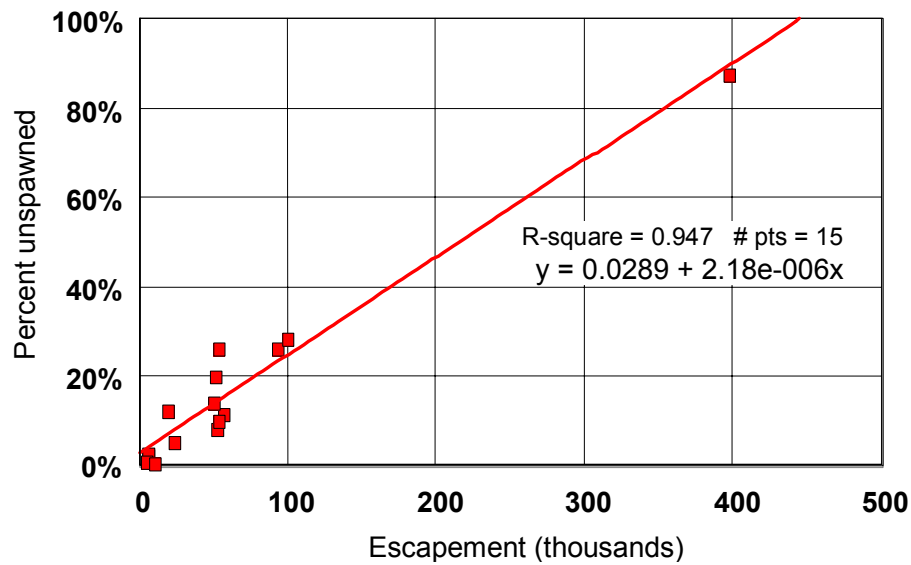
The MOU requires the following monitoring, all of which is being conducted:

### Analysis of Fish Passage Over Natural Barriers

*Adult Population Estimates at the Weir.* The hatchery fish trap provides reliable estimates of the numbers of fish entering the hatchery. Video monitoring is also part of the monitoring system. The unknown part of the process is due to some fish passing the weir when flows exceed about 300 cfs. Field staff still needs to handle the fish to collect tissues for genetic analysis and to recover coded wire tags. The USFWS is considering modifying trap operations by running the trap more hours per day (allowing more fish to pass) shifting operations to peak periods, and shifting operations to cooler periods. The goal is to reduce the impacts of trap operations.

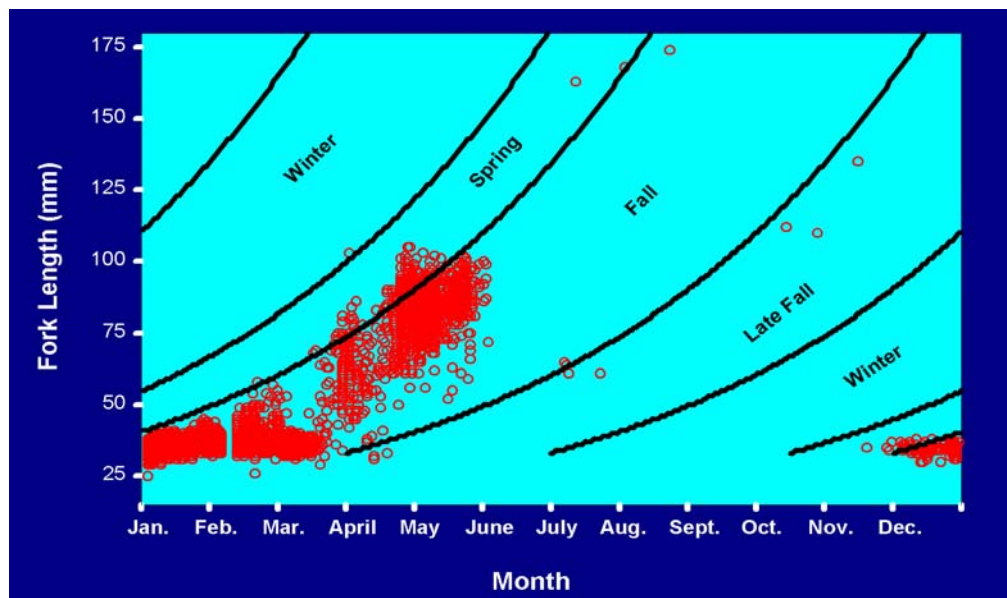
Brown pointed out that in the past five years, only five winter Chinook were passed into upper Battle Creek (see Figure 15).

*Snorkel and Redd and Spawning Surveys for Adults.* Brown noted that surveys for spawning steelhead are often difficult because of high flows and turbidity. As shown in Figure 40, in 2002 there was a large percentage of unspawned fall Chinook in Battle Creek. (2002 is the point to the upper far right on the x axis.)



**Figure 40. Pre-spawning mortality vs. escapement, 1988–2002. Source: Matt Brown. Data from Colleen Harvey-Arrison, DFG.**

*Rotary Trapping for Juveniles.* The USFWS operates two RSTs: one above the weir and one in lower Battle Creek. The trap catches (plus trap efficiency estimates) are used to estimate production of the various Chinook races and steelhead. Length-at-date data (based on estimates of growth) are used to identify salmon races. There are problems keeping the traps operating during high flows. Figure 41 shows some typical length data for fish collected in the upper track. Although most of the fish are shown to be fall juveniles, there is very likely some overlap in emigration timing and some of the fish could actually be spring or late fall.



**Figure 41. 1999 upper Battle Creek length distributions by run**



*Water Temperature.* Water temperature measurements are of particular importance when evaluating the benefits of interim flows in the North and South forks. Interim flow monitoring benefits included:

- Provide basis for increased flows in South Fork;
- Detect fish in places where they shouldn't be, improve future PG&E operations;
- Identify temporary passage barrier in North Fork;
- Identify increased mortality to spring Chinook; and
- Provide analysis of natural barriers.

Brown identified additional monitoring and research needs included in the adaptive management plan:

#### Adaptive Management Plan

- Fish tagging or radiotelemetry
- Instream Flow Incremental Methodology
- Short-term flow increases for temperature regulation and fish passage

#### Restoration Project Monitoring Plans

- Adaptive Management Plan
- Facilities Monitoring Plan
- Post-Construction Evaluation and Assessment
- Operation and Maintenance Plan

#### Research to apply to this and other CALFED projects

- Verify approach based on IFIM
- Verify juvenile habitat use and availability
- Effects of dam removal on sediment dynamics and stream channel

## **The Big Picture**

*Wim Kimmerer, San Francisco State University*

This presentation was not included in the distributed workshop agenda but was added, at the request of the science panel, to provide a better understanding of the Central Valley system outside of Battle Creek and the Coleman NFH. Kimmerer cobbled the presentation together from miscellaneous materials on his laptop. A couple of slides were added here that were not shown at the workshop.

Kimmerer started the presentation with the general salmonid life cycle (Figure 42), including the spawning, incubation, rearing, emigration and ocean stages. The exact timing of these stages is somewhat complicated in the Central Valley since there are four races of Chinook salmon and steelhead trout. As shown in Figure 43, there is considerable variation among the salmon races, with spawning time ranging from mid-summer to mid-winter. (This figure was not shown at the workshop but is one of the sources for Figure 4.1-1 in the draft EIS/EIR). Individual Chinook salmon races exhibit considerable plasticity – emigration timing (and size of emigrants) can vary considerably from stream to stream and among years. Spring Chinook may exhibit the most plasticity, and information from Mill, Deer, and Butte creeks demonstrates that Spring Chinook emigrate from these streams as young of the year (YOY) and yearlings. Ratios of YOY to yearlings are unknown and may vary annually and between streams. Also spring run yearlings can emigrate over an 8-month period, from October through May. YOY can emigrate over a 9-month period, from November through July (C. Harvey-Arrison, DFG, personal communication).

Kimmerer used the map shown in Figure 44 to illustrate some of the major features of the Central Valley system – and the potential perils salmon may encounter on their way to and from the ocean.

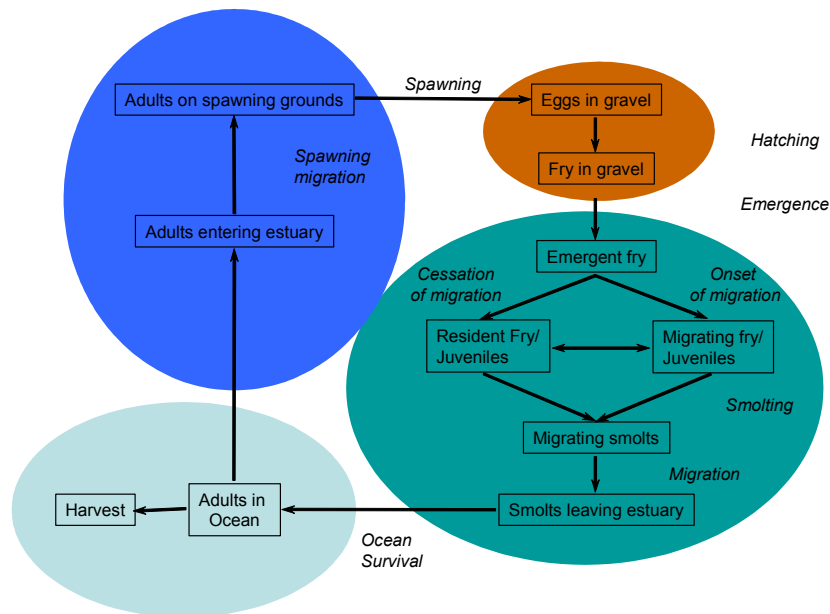


Figure 42. General salmonid life cycle. Source: Wim Kimmerer.

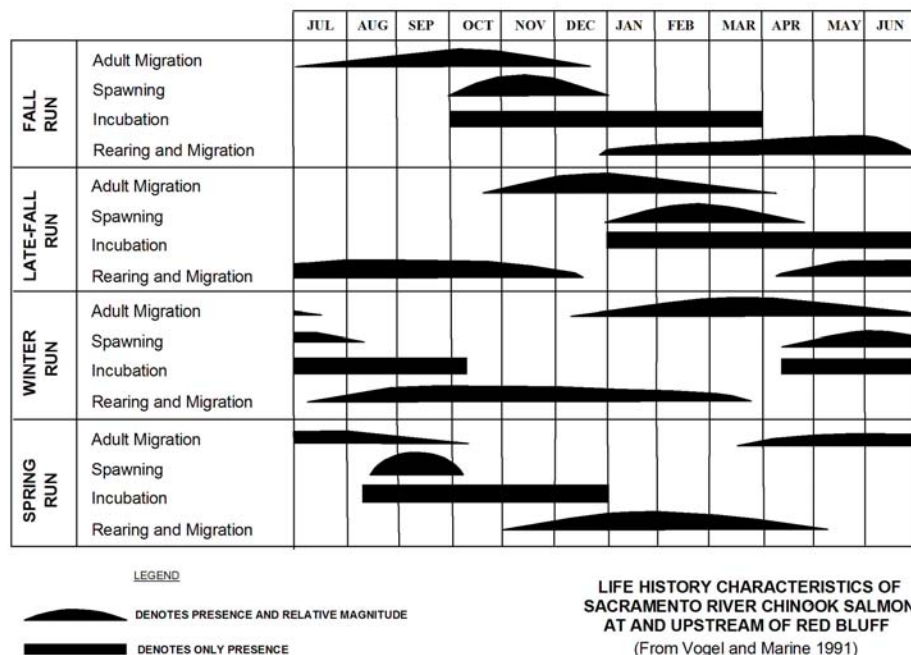
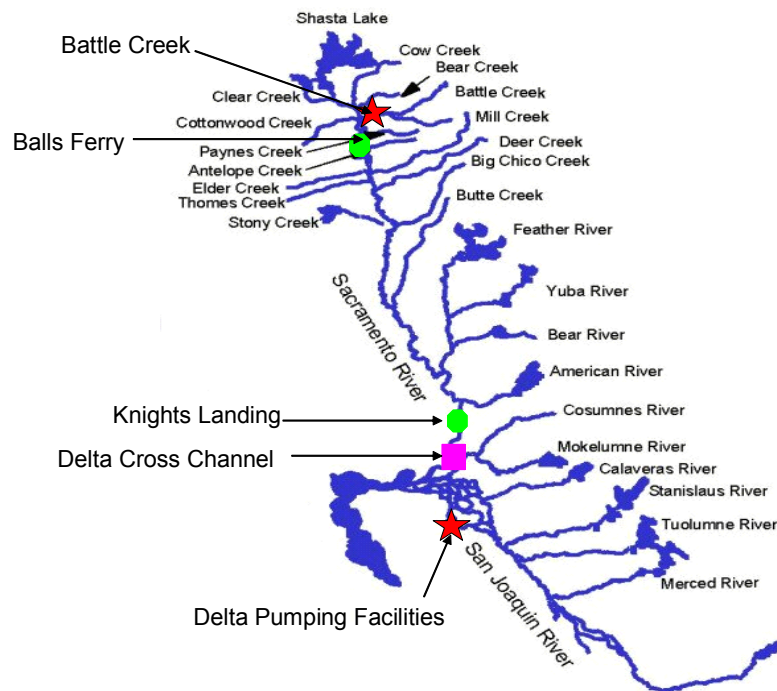


Figure 43. Life history characteristics of the Sacramento River Chinook salmon at and upstream of Red Bluff (From Vogel and Marine 1991). Presentation by Wim Kimmerer.



**Figure 44. Map of major features of the central Valley. Source: Phil Gaines. Presentation by Wim Kimmerer.**

A few of these features:

*The Red Bluff Diversion Dam.* A low-head operable barrier is operated by the USBR to provide head needed to divert water from the Sacramento River into the Tehama-Colusa Canal. Due mainly to ESA concerns (delays in migration, increased predation, inadequate fish ladders) the dam gates are down only during the summer months. The RBDD is below the major winter Chinook spawning area and the USFWS operates four rotary screw traps to index the numbers of winter Chinook emigrants and their emigration timing.

*Balls Ferry.* Until recently the site of a DFG rotary screw trap operation to sample emigrating salmonids.

*Glenn-Colusa Irrigation District.* A large (about 3,000 cfs) diversion that was recently re-screened with state of the art positive barrier fish screens. (The location is not shown on the map but is about midway between Balls Ferry and Knights Landing.) There is a screw trap operation at GCID to provide another snapshot of salmon movement.

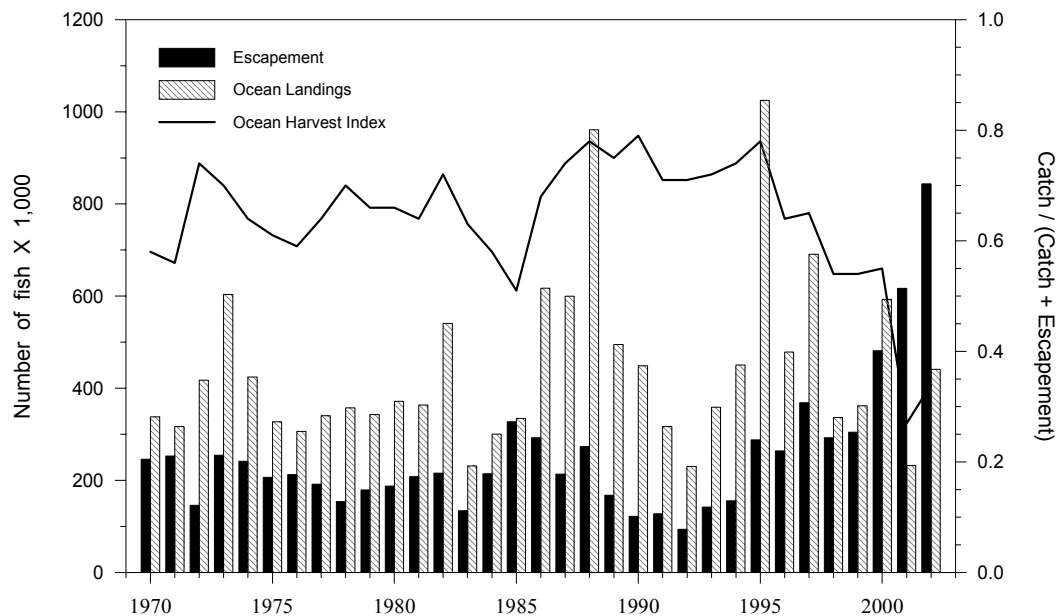
*Knights Landing.* A DFG screw trap operation at this site provides the last look at the emigrating salmon before they enter the Delta.

*The Delta and San Francisco Estuary.* It is beyond the scope of this report to discuss the complexities of the Delta and estuary and how these effect salmon, but a few points may help. (Interested readers see Brown and Kimmerer 2001 for a more complete description.)

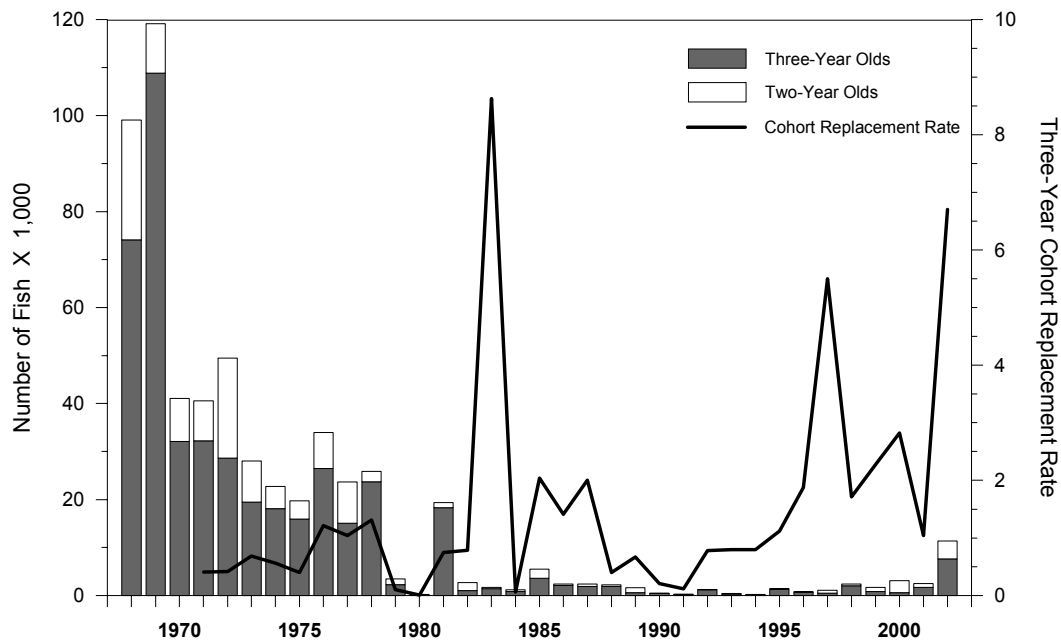
- *Sacramento River* – below the mouth of the American River. A mid-water trawl sampling site operated by the USFWS as part of the Interagency Ecological Program's (IEP) estuarine salmon studies.

- *Delta Cross Channel* – a feature of the Central Valley Project that allows diversion of Sacramento River water into the interior Delta and to the export pumps. The cross channel gates are operated by the USBR and, by a NOAA biological opinion, are closed from February 1 to May 31 each year to protect juvenile Chinook salmon emigrating from the Sacramento basin.
- *South Delta Pumping Plants* – The Central Valley and State Water projects in the south Delta have the combined pumping capacity of close to 15,000 cfs but existing regulations limit pumping to a combined pumping of about 10,500 cfs. IEP, CALFED and others are investigating the effects of these pumps on juvenile salmon rearing in and emigrating through the Delta.
- *Chippis Island* – another IEP trawling site located on the western edge of the Delta. One of the main purposes of this sampling program is to collect coded wire tags from fish released at hatcheries and by special studies designed to index survival from the release site through the Delta.
- *Ocean* – the largely unknown system. DFG does conduct (with IEP support) an ocean salmon program to help estimate harvest by the recreational and commercial fisheries and to recover coded wire tags.

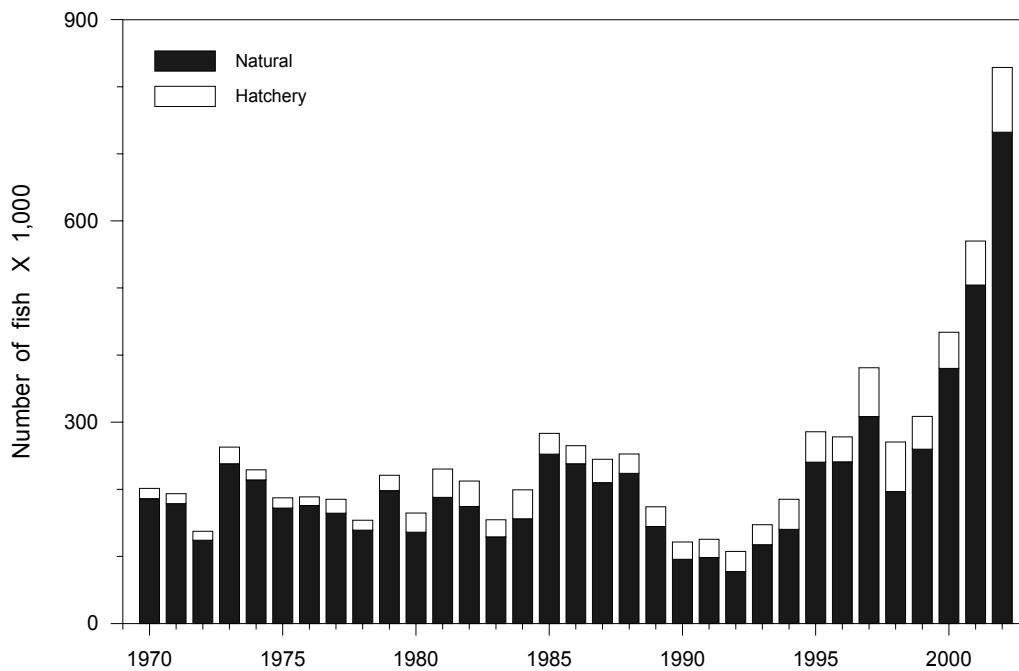
Kimmerer presented information on recent trends in escapement and ocean catch and harvest, Figures 45 through 49. Note that the hatchery numbers are strictly those fish taken into the hatcheries, not the numbers of hatchery fish spawning in the stream. On the Feather River, for example, in 2002 it looked like at least 50% of the spawners were of direct hatchery origin (B.Cavallo, Dept. of Water Resources, personal communication). It is also important to note the relatively recent decline (to around 20% in the 2002 fishing season) in the fraction of the fish being harvested in the ocean. In Figure 50, the recent winter Chinook escapements are plotted on a log scale, showing that the animal has made good recovery since the low around 1990. It appears that there is a relationship between ocean conditions and escapement (Figure 51).



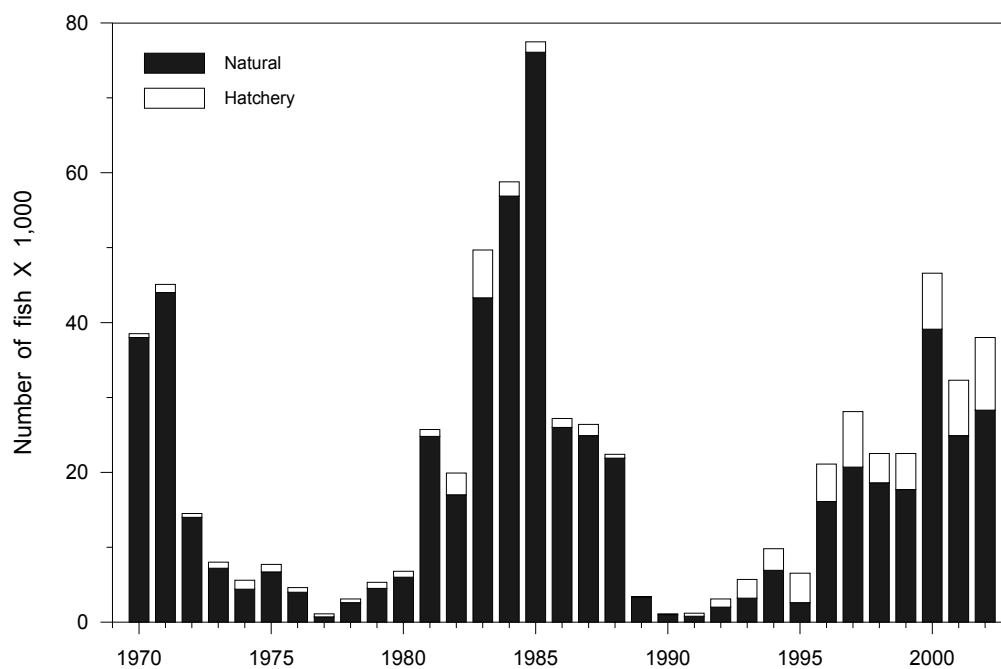
**Figure 45. PPMC Chinook salmon ocean catch, the Central Valley fall run Chinook adult spawner escapement and ocean harvest index, 1970–2002. From Chappell 2003.**



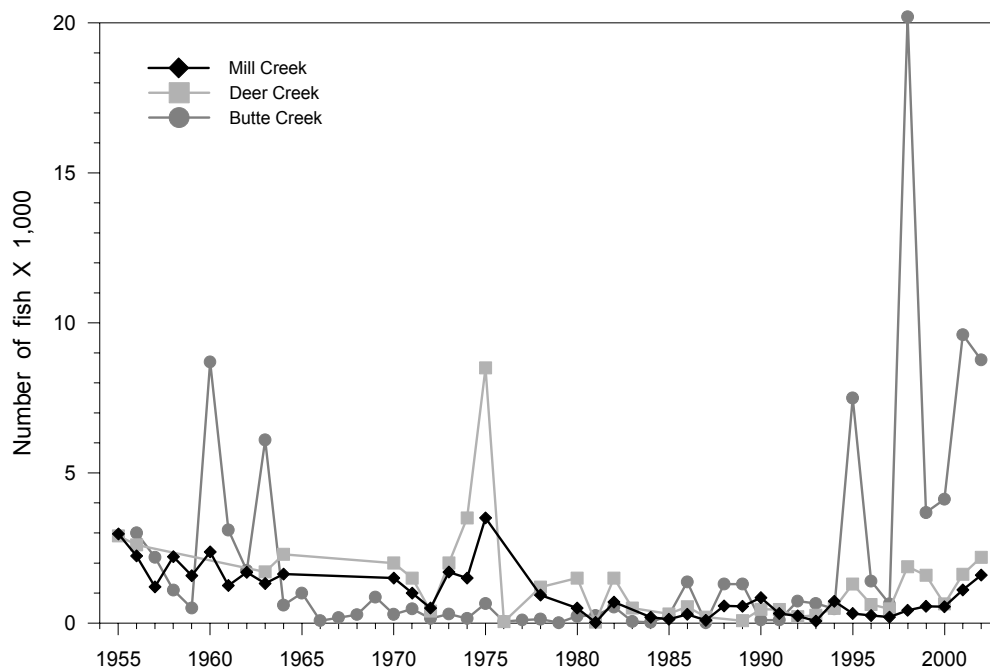
**Figure 46. Annual winter run Chinook salmon cohort escapement and the 3-year cohort replacement rate to the upper Sacramento River, 1967–2002. From Chappell 2003.**



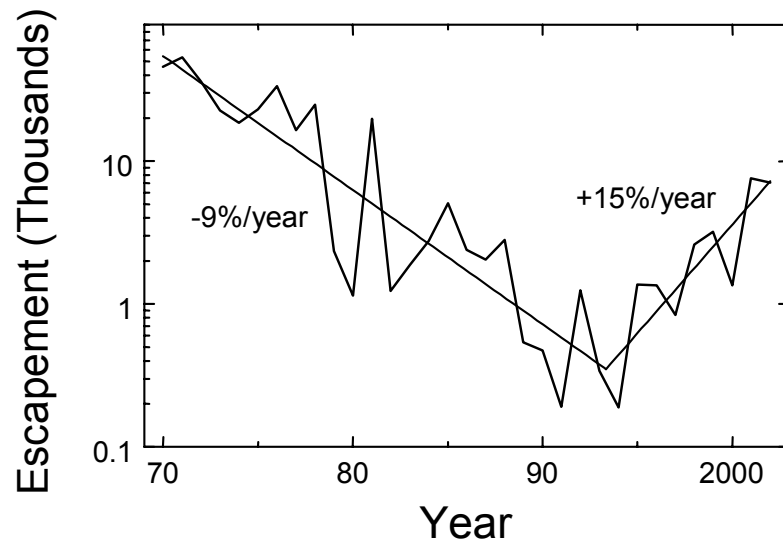
**Figure 47. Annual fall run Chinook salmon escapement to the Sacramento River and major tributaries, natural and hatchery contribution, 1970–2002. From Chappell 2003.**



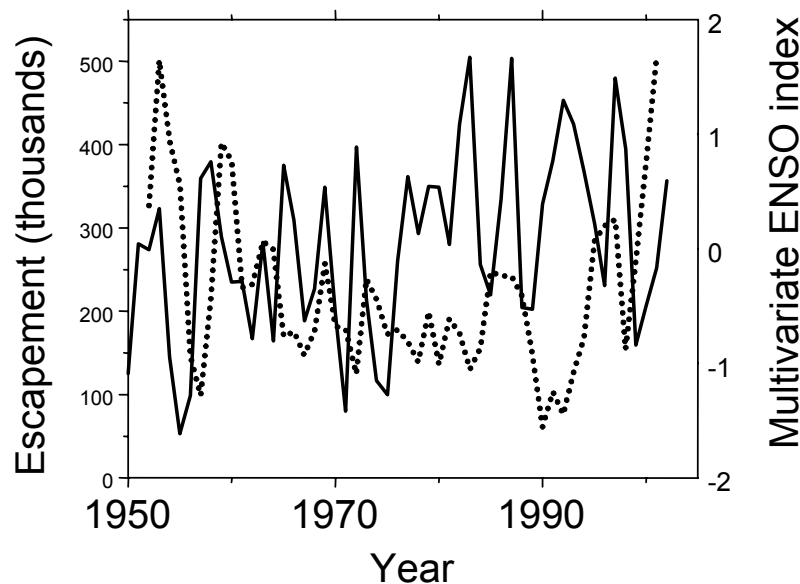
**Figure 48. Annual fall run Chinook salmon escapement to the San Joaquin River system, natural and hatchery contribution, 1970–2002. Source: Chappell 2003.**



**Figure 49. Annual spring run Chinook salmon escapement to Mill, Deer, and Butte creeks, 1956–2002. Source: Chappell 2003.**



**Figure 50. Escapement. Source: Wim Kimmerer.**



**Figure 51. Sacramento River fall Chinook escapement. Source: Wim Kimmerer.**

Table 8 provides some estimates of factors being used to calculate the numbers of winter Chinook juveniles entering the Delta. The footnotes indicate the source of the information. The two columns are being used to compare estimates derived from carcass surveys and counts of winter Chinook moving up fish ladders at the Red Bluff Diversion Dam. With the dams gates now open during much of the winter Chinook adult migration period, the diversion dam counts no longer provide accurate escapement estimates, thus the agencies are moving to the more reliable carcass survey studies. The entire exercise – the Juvenile Production Estimate – is part of calculating the numbers of juvenile winter Chinook that can be taken (killed) at the intakes to the state and federal water projects in the South Delta. The “red light” limit is 2% of the calculated production estimate. The water projects and fish agencies take measures to avoid going through the red light limits.

**Table 8. Values used to calculate numbers of juvenile winter Chinook entering the Delta**

	<i>Carcass Survey</i>		<i>RBDD Ladder</i>	
	<i>Factors</i>	<i>Estimate</i>	<i>Factors</i>	<i>Estimate</i>
Adult spawner estimate		7,337		9,172
Adult female estimate <sup>a</sup>	0.783	5,745	0.474	4,348
Effective spawner population <sup>b</sup>	0.013	5,670	0.013	4,291
Ova per female <sup>c</sup>	4,923	27,914,334	4,923	21,124,643
Egg loss due to high water temperature <sup>d</sup>	0.002	55,829	0.002	42,249
Total viable eggs		27,858,505		21,082,394
Egg-to-smolt survival <sup>e</sup>	0.1475	4,109,130	0.1475	3,109,653
Smolt survival to Delta <sup>f</sup>	0.52	2,136,747	0.052	1,617,020
Natural production entering the Delta		2,136,747		1,617,020
Red light level (2.0%)		42,735		32,340

a. 2002 DFG carcass survey observed proportion of adult females, no grilse.

b. 2002 DFG carcass survey estimated pre-spawning mortality from fresh carcass observations.

c. USFWS Livingston Stone NFH average fecundity from 2002 broodyear spawning records.

d. Determined from aerial redd surveys and proportion spawning below temperature compliance point at Jellys Ferry Bridge.

e. Based on USFWS Tehama-Colusa spawning channel studies, 1975-1980.

f. Based on ocean recoveries of paired coded wire tagged late fall Chinook releases from Battle Creek, 1994-1999 (USFWS unpublished 2003 data).

Kimmerer ended his presentation with a brief description of some components of a conceptual life cycle model he and his colleagues developed for Central Valley Chinook salmon.



## **Selected References**

- Banks MA, Rashbrook VK, Calavetta MJ, Dean CA, Hedgecock D. 2000. Analysis of microsatellite DNA resolves genetic structure and diversity of Chinook salmon in California's Central Valley. *Canadian Journal of Fisheries and Aquatic Sciences* 57:915-927.
- Brown RL, Kimmerer W. 2001. Environmental and institutional background for CALFED's Environmental Water Account. Sacramento (CA): CALFED Bay-Delta Program. 53 p.
- CALFED Battle Creek Technical Review Panel. 2003. Battle Creek salmon and restoration project. Final report submitted to the CALFED Bay-Delta Program. Sacramento, CA. 36 p.
- Kier & Associates. 1999a. Battle Creek salmon and steelhead restoration plan. Prepared for the Battle Creek Working Group. Red Bluff, CA. 151 p.
- Kier & Associates. 1999b. Maximizing compatibility between Coleman National Fish Hatchery operations, management of lower Battle Creek, and salmon and steelhead restoration. Report to the Battle Creek Working Group. Red Bluff, CA. 54 p.
- Kimmerer W, Mitchell W. 1999. Conceptual framework for the Sacramento River chinook salmon individual based model. Project report for USFWS. Sacramento, CA. 44 p.
- Nielsen JL, Tupper D, and others. 1994. Mitochondrial DNA polymorphism in unique runs of Chinook salmon from the Sacramento-San Joaquin River basin. *Conservation Biology*. 8:882-884.
- Nielsen, JL, Parvey S, Wiacek T, Sage CK, Williams I. 2003. Genetic analysis of Central Valley trout populations, 1999-2003. Technical report submitted to CDFG and USFWS. Sacramento, CA. 44 p.
- Waples RS, Teel DJ, Myer JM, Marshall A. Life history divergence in Chinook salmon: historic contingency and parallel evolution. *Evolution*. Forthcoming.
- Warren JW. 1991. Diseases of hatchery fish, 6th edition. Washington, DC: USFWS.
- Williamson KS, May B. 2003. Homogenization of fall-run Chinook salmon gene pools in the Central Valley of California. Project completion report to CDFG. Sacramento, CA. 150 p.

## **Appendix A: List of Documents Sent to Science Panel**

- The 2001 USFWS biological assessment of effects of operation of Coleman NFH.
- A Battle Creek Watershed Conservancy report, "Maximizing compatibility between Coleman National Fish Hatchery Operations, Management of Lower Battle Creek, and Salmon and Steelhead Restoration." Published by Kier Associates in 1999.
- A 2001 proposal to the Packard Foundation from the Battle Creek Watershed Conservancy, "Managing Risk to Facilitate the Success of the Battle Creek Salmon and Steelhead Restoration Project"
- CDs of the Battle Creek Salmon and Steelhead Restoration Project - Draft EIR/EIS - Main report (Disc 1) and Appendices (Disc 2).
- Descriptions of alternate actions and operations at Coleman NFH being considered by the U.S. Fish and Wildlife Service and other interested parties.
- Volume 1 of California Department of Fish and Game Fish Bulletin 179. The panel was particularly encouraged to consider material in the papers on Central Valley salmon genetics, history of the Coleman NFH and historical abundance of Chinook salmon in the Central Valley.
- A 2002 USBR report, "Coleman National Fish Hatchery Barrier Weir - Preliminary Concept Study Report"
- A 1999 Kier Associates report, "Battle Creek Salmon and Steelhead Restoration Plan"
- Technical Review Panel - Battle Creek Salmon and Steelhead Restoration Project. A September 2003 report to CALFED.
- Page from AFRP Working Paper on Restoration Needs, Vol. 3, describing salmonid goals for Battle Creek.
- A memorandum dated 12/16/94 from Steve Croci (USFWS) to Dave Hoopaugh (DFG) on the Battle Creek plan.
- Thorpe, JE. 1994. Salmonid flexibility: response to environmental extremes. *Trans Am Fish Soc* 123:606-612.
- Microsoft PowerPoint slides from the workshop presentations.
- Draft copy of Michael Ward's watershed assessment.
- Copy of Williamson and May (2003) report to CALFED about genetics of Central Valley fall run Chinook salmon.
- Copy of Weber and Fausch 2003a – a report on competition between the hatchery and naturally spawned juvenile salmon on the upper Sacramento River.
- Copy of Weber and Fausch 2003b – a paper on the above project published in the *Canadian Journal of Fisheries and Aquatic Sciences*.
- Step 1 Report. Conceptual framework for an integrated life cycle model of Winter-run Chinook salmon in the Sacramento River. By Steve Cramer and Associates, 2003.

## **Appendix B: Agenda**

Battle Creek Workshop  
October 7 and 8, 2003  
Red Bluff Community Center  
Red Bluff, California

### **Day 1: October 7, 2003**

- 0800 Refreshments, Coffee, Sign In
- 0830 Welcome, Introductions, Workshop Format – Kimmerer
- 0840 Stakeholder Perspectives
  - The Battle Creek Conservancy – Lee
  - Pacific Coast Federation of Fisherman's Associations – Kier
  - Metropolitan Water District – Hoyer
  - Central Valley Project Water Users – Birk
- 0920 Battle Creek Restoration and the Workshop: A CALFED perspective – Castleberry
- 0940 The Battle Creek Watershed – Ward
- 1000 The Proposed Battle Creek Restoration Project – Rectenwald
- 1030 Break
- 1045 Coleman and Livingston Stone National Fish Hatcheries – Hamelberg
- 1115 Recent status of Chinook Salmon and Steelhead in the Central Valley and Battle Creek – Null and Niemela
- 1145 Discussion Among Science Panel and Speakers
- 1200 Lunch
- 1300 Diseases in Central Valley, Basin and Hatchery – Foott
- 1330 Disease Transmission and Preventative Measures – Cox
- 1400 Discussion among Science Panel and Speakers
- 1415 Questions from the Audience
- 1430 Break
- 1500 The Fish Barrier Dam, Ladder, and Collection Facilities
  - Existing Facilities and Operations – Hamelberg
  - Historic Fish Passage over Barrier as Affected by Hydrology – Rectenwald
  - Proposed Changes – Hamelberg
- 1630 The Greater Battle Creek Working Group and MOU – McNutt
- 1645 Questions from the Audience
- 1700 Adjourn for the Day
- 1830 Hosted Informal Reception at Local City or State Park

## **Day 2: October 8, 2003**

- 0730 Refreshments and Coffee
- 0800 Genetics of Central Valley steelhead – Nielsen
- 0830 Genetics of Central Valley Chinook Salmon – Banks
- 0900 Coleman NFH: Founding Stock, Broodstock Collection, and Spawning – Hamelberg
- 0930 Battle Creek Steelhead – Campton
- 1015 Break
- 1030 Water Quality in Lower Battle Creek – Boles
- 1015 Break
- 1115 The NOAA Biological Opinion – Witalis
- 1145 Discussion Among Panel Members and Speakers
- 1200 Lunch
- 1245 Alternative Hatchery Facilities and Operations under Consideration – Ward
- 1315 The Winter Run Experience at Coleman NFH and Livingston Stone NFH – USFWS
- 1350 Monitoring of the Restoration Project at the Coleman NFH Barrier Dam and in Battle Creek –  
Matt Brown
- 1420 Discussion and Questions Among Panel, Speakers, and Audience
- 1430 Adjourn

## Appendix C: Attendance List

Battle Creek Workshop  
October 7 and 8, 2003  
Red Bluff, California

Alston, Naseem ..... USFWS  
Anderson, Curtis ..... DWR  
Anderson-Abbs, Beverly .....  
Banks, Michael ..... Oregon State University  
Benthin, Randy ..... DFG  
Birk, Serge ..... CVP Water Users' Association  
Brown, Matt ..... USFWS  
Brown, Randy ..... CBDA  
Burke, Kerry ..... Mill Creek Conservancy, landowner  
Busack, Craig .. Washington Dept. Fish and Wildlife,  
panel member  
Campton, Don ..... USFWS  
Castleberry, Dan ..... CBDA  
Cox, Bill ..... DFG  
De Staso, Jim ..... USBR  
Earley, Jim ..... USFWS  
Faulkner, Jimmy ..... USFWS  
Ferris, Scott ..... NorCal Fishing Guides  
and Sportsmens Association  
Foott, Scott ..... USFWS  
Fris, Rebecca ..... CBDA  
Gaither, Shea ..... USFWS  
Hamaker, Tim ..... CH2MHill  
Hamelberg, Scott ..... USFWS  
Hankin, Dave ..... Humboldt State University, panel  
member  
Hedrick, Ron... University of California, Davis, panel  
member  
Hirsch, Steve ..... MWD  
Hoye, Walt ..... MWD  
Jacobs, Diana ..... DFG  
Kankowski, Ethan ..... USFWS  
Kier, Bill ..... Pacific Coast Federation of Fishermen's  
Associations  
Kimmerer, Wim ..... CBDA, SFSU  
Laster, Eric ..... DWR

Lichatowich, Jim ..... Alder Creek Consulting, panel  
member  
Lucas, Larry ..... BCWC  
Machula, Jana ..... CBDA  
McCarthy, James .....  
McFarland, Melanie ..... USDA Forest Service  
McNutt, Peggy ..... The Nature Conservancy  
Miyamoto, Joe ..... East Bay Municipal Utility District  
Moeller, Phil ..... USFWS  
Navicky, James ..... DFG  
Navicky, Jennifer ..... DFG  
Nielsen, Jennifer ..... USGS  
Niemela, Kevin ..... USFWS  
Null, Bob ..... USFWS  
Paquin-Gilmore, Sharon ..... BCWC  
Parker, Tricia ..... USFWS  
Phipps, Jeff .....  
Ray, Adam ..... USFWS  
Rectenewald, Harry ..... DFG  
Reisenbichler, Reg ..... USGS, panel member  
Risdon, Angela ..... PG&E  
Sansum, Herbie ..... BCWC  
Scott, John ..... USFWS  
Sitts, Rick ..... MWD  
Smith, Jim ..... USFWS  
Smith, Russell ..... USBR  
Stalica, Chip ..... PG&E  
Stein, Karl ..... BLM  
Steitz, Curtis ..... PG&E  
Taylor, Kim ..... CBDA  
Totzke, Kane ..... Kern County Water Agency  
Tupen, Jeff ..... CH2MHill  
Walfoort, Walt ..... USFWS  
Ward, Mike ..... BCWC  
White, Wayne ..... USFWS  
Witalis, Shirley ..... NOAA Fisheries